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SEPTEMBER ISSUE ☆ ☆ ☆ 1959 NR. 3

FIGHTER WEAPONS NEWSLETTER

USAF FIGHTER WEAPONS SCHOOL

NELLIS AIR FORCE BASE • LAS VEGAS, NEVADA

YOUR NEWSLETTER

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TABLE of CONTENTS

SECTION I GENERAL INTEREST

CHANGE OF COMMAND 2
A NEW LOOK 4
CLASS 60-A 8
OPERATION FLYING BROTHERS 10
WHO SAYS WE CAN'T 11
THE TAC TEST PROGRAM 13

SECTION II WEAPONS

AIR TO GROUND CENTURY STYLE 16
ELUSIVE DART 29
COMBAT PROFILE 34
PREFLIGHT PLANNING FOR TURNS 37
LABS GYRO MOD 39
NEW GYRO LEVELING FIXTURE 40
QUIZ 41
GAR-8 TACTICS 42
TEMPERATURE vs INFRARED 44
QUICK, DIRTY AND CHEAP 45
DART TOW CABLE MOD 48

COVER: F-100 Fires the new GAM-83 "Bullpup" air to ground missile. Illustrated by S/Sgt Donald H. Tracy.

CHANGE OF COMMANDS

Lt. Colonel Floyd White, Commander of the USAF Fighter Weapons School for the past two years, has been reassigned to Headquarters, TAC, as Chief of the TAC Operations Branch.

When Colonel White assumed command of the FWS in May 1957, the Weapons Instructor Course was on a standby status and only the TR&D Section, with a handful of aircraft and personnel, was active.

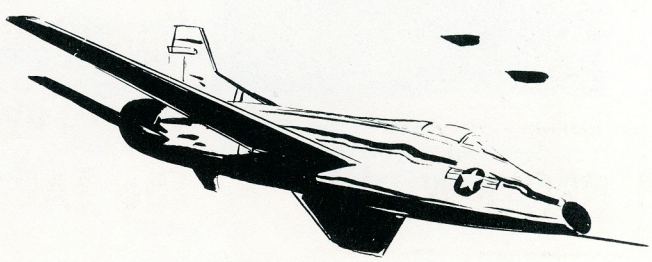
Through the persistent efforts and outstanding leadership of Colonel White, many changes were made in the following year. In February 1958, the FWS was transferred from ATC to TAC and, in a short period of time, grew from 23 officers and 7 airmen to 49 officers and 385 airmen with 41 F-100D's, 5 F-100F's, 3 T-33's and 1 C-47. The first Instructor class started in July '58 and the first TAC rotational squadron arrived in August. In addition to the TR&D function and the worldwide liaison visits, the FWS has graduated 4 Weapons Instructor Classes and 21 TAC squadrons have rotated through Nellis for weapons training.

Congratulations to Colonel White on a job well done and best wishes on his new assignment.

Colonel Ralph F. Newman, formerly Deputy Wing Commander, 401st TAC Ftr. Wg., England AFB, Alexandria, Louisiana, replaces Lt. Colonel White as commander of the USAF Fighter Weapons School.

Colonel Newman has an extensive background in fighter and fighter reconnaissance aviation. After two combat tours in fighter reconnaissance in World War II and four years in the Pentagon as a Staff Planning Officer, he commanded the 613th Tactical Fighter Squadron for five years at England AFB.

Under the guidance of Colonel Newman, the USAF Fighter Weapons School looks forward to newer and better weapons systems and to remain as the center of Tactical Fighter Aviation.



GENERAL INTEREST

- Change of Command
- A New Look
- Class 60-A
- Operation Flying Brothers
- Who Says We Can't?
- The TAC Test Program

SECTION I

A New LOOK

By: Major Norman C. Gaddis
O&T Section

Twice within one decade American Airpower was called upon to meet the challenges of aggressor nations. From these conflicts came many lessons on the use of tactical airpower. World War II, fought on a global basis, pointed out the need for bigger bombs, more accurate bombing systems, new methods of bomb delivery, precise navigation systems, electronic countermeasures, higher aircraft speeds, higher altitude capabilities, refined aircraft escape systems, better personal flying equipment, etc. The Korean War, confined to a relatively small geographical area, revealed that significant progress had been made in the aforementioned areas; however, national policy dictated that the bigger bombs (i.e. nuclear) would not be used to support United Nations objectives. Consequently it was necessary for tactical aircrews to deliver non-nuclear weapons against aggressor targets in North Korea.

Later events - the Lebanon and Formosan Crises - showed that tactical airpower would be called upon again and again to support national policy in the event of limited or "brushfire" wars. In a limited war there is a definite requirement for the tactical aircrew to be capable of delivering non-nuclear ordnance. It is reasonably safe to assume that this requirement will not diminish in the immediate years ahead so long as the Communist aim remains unchanged.

Based upon the concept that tactical airpower will be called upon to deploy to "trouble spots" throughout the world, TAC is now requiring their fighter aircrews to qualify in certain events of non-nuclear weapons delivery. TACR 50-1, dated 28 May 1959, requires annual qualification in low angle strafing, dive bombing, napalm delivery and aerial attack against dart targets.

Prior to the time that TAC decided to qualify their crews in non-nuclear ordnance delivery a comprehensive study was conducted by the USAF Fighter Weapons School to determine the adequacy of the Fighter Weapons Instructor Course. The results of the study indicated that certain changes should be made in the curriculum in order to provide the students with the latest information on new weapons, delivery systems and training concepts. It was unanimously agreed that the dart target

should replace the banner target in the aerial attack phase; that the GAM-83 (Bullpup) air-to-ground guided missile be included in the ground attack phase, GAR-8 tactics be added to the regular tactics phase and the retarded delivery procedures for the newest nuclear weapons be incorporated in the nuclear weapons phase.

The following academic and flying training program has been recommended to TAC as the basic curriculum for the Fighter Weapons Instructor Course:

ACADEMICS	HOURS
Course Orientation and Batori Computor	3:00
Aerial Attack	27:00
Nuclear Weapons Delivery, Equipment and Weapons Safety	39:00
Fire Control System	12:00
Aircraft Harmonization	9:00
Ground Attack (Non-Nuclear)	12:00
	102:00

FLYING	SORTIES	HOURS
Orientation	1	1:15
Aerial Attack		
(1) Banner-Subsonic	3	3:00
(2) Dart-Trans-Sonic	7	7:00
(3) Air-Combat Maneuvering	7	7:00
Ground Attack (Non-Nuclear)		
(1) High Angle Bombing, Rocketry Low Angle Strafing	3	3:30
(2) Low Angle Bombing, Rocketry Low Angle Strafing	3	3:30
(3) Interdiction	1	1:00
*(4) Air-to-Ground Guided Missile (GAM-83)	2	2:00

*Dependent upon availability of training missiles.

Ground Attack (Nuclear)			
(1)	Low Altitude Bomb System (O/S)	5	5:00
(2)	High Altitude Dive Bombing	4	4:00
(3)	Dive-Toss Bombing	3	3:00
(4)	Combat Profile Missions	4	6:00
(5)	MSQ/APW-11 Bombing	1	1:45

*Dependent upon availability of training weapons.

*(6)	LABS - (Laydown)	2	2:00
(7)	LABS - (Retarded)	2	2:00
		46	50:00

GROUND TRAINING	HOURS
Briefings (Mission preparation, phase and sortie briefings)	74:00
Mission Critiques	28:00
Camera Film Assessing	8:00
Target Folder Study (CPM)	12:00
*GAM-83 Simulator Training	4:00
Field Trips	4:00
(1) Harmonization Range	
(2) Armament and Electronic Section	
(3) Dart and Banner Tow Section	
Flying Safety	11:00
	141:00

*Dependent upon availability of simulator trainer.

Class 60-A

The first class of fiscal year 1960 of the USAF Fighter Weapons Instructor's Course got underway on 8 July. They are scheduled to graduate 16 September. Upon successful completion of the course they will be awarded AFSC W1115 B, as qualified weapons instructors.

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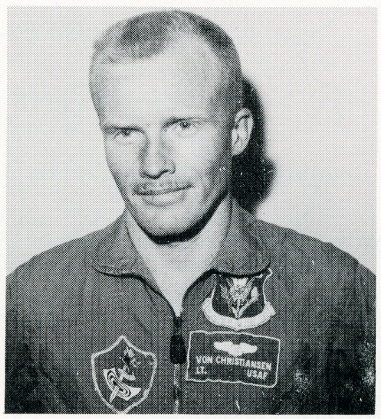

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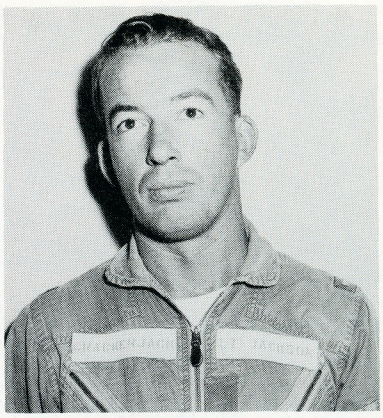

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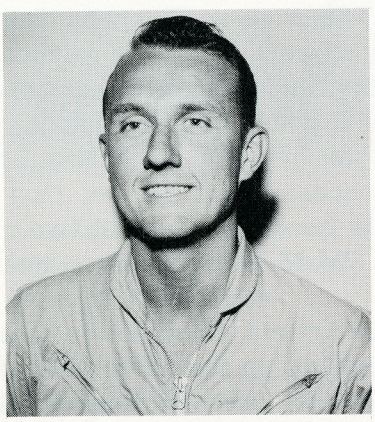

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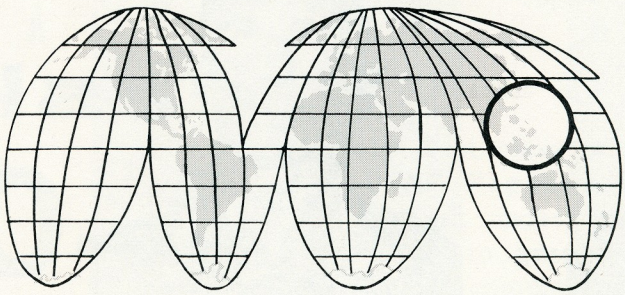
OPERATION *Flying Brothers*



NOTE: This article was written by Major "Hoot" Gibson, Commander, 4521st CCRTRG Sqdn. Major Gibson headed the Fighter Weapons Advisory Team on operation "Flying Brothers."

The Pacific Fighter Weapons Conference was a joint non-competitive fighter gunnery exercise held at Clark Air Base, Philippines from 24 April 1959 to 7 May 1959 to assist Free Asian Air Forces with the tactical and technical problems of fighter weapons employment. All phases of air-to-air and air-to-ground gunnery were covered. The Royal Thai Air Force and the United States Air Force and Navy participated. Each team fired six (6) air-to-air and six (6) air-to-ground missions.

The Philippine Air Force, commanded by General Pedro Q. Molina, and the United States 13th Air Force, commanded by Major General Thomas S. Moorman, were co-hosts. A letter of invitation, signed by General Molina and General Moorman, was dispatched to all participating and observing nations. Countries invited to participate were Korea, Japan, Republic of China, Thailand, the Philippines and the United States. Japan was unable to participate but did send observers. Countries invited to send observer teams were the United Kingdom, Cambodia, Vietnam and Laos. Laos was unable to attend and declined the invitation.

The conference started on schedule with the arrival of the teams on the 24th and 25th of April. Everything went as planned without any accidents or incidents during the entire flying phase. Since the conference was non-competitive scores were not released, but all of the fighter weapons instructors who assisted the teams during the conference were highly pleased with the performance of the air crews. They all showed a high degree of skill in the employment of their weapons systems. Overall scores compared favorably with those fired in the USAF Weapons Meet. Particularly impressing was the high quality maintenance and the knowledge demonstrated by the armament personnel of each team. It was evident that each country was well prepared and the esprit de corps was high. It was gratifying to note the willingness of participants from one country to help those from another. When one team needed assistance, another was eager to render aid in the form of equipment or men.

All staff members and participating personnel deserve a word of praise for a job well done. The Fighter Weapons Team consisting of five officers and three airmen from Nellis, Williams, and Luke AFB enjoyed every moment of this conference and it is their earnest desire to be able to participate in similar conferences. In the future, they would like to see this become a competitive meet, perhaps later a World Wide Weapons meet.

This article would not be complete without giving credit to the officer who originated the idea, Colonel James P. Hagerstrom of PACAF. Colonel William B. Harris, project officer, and Captain Oscar M. Alejandro, PAF project officer, deserve a word of praise for a job well done.

WHO SAYS WE CAN'T?

By: Captain Leslie Dyer
434th Tactical Ftr Sqdn
George AFB, Calif

We often hear "So it's pretty and goes like the proverbial bat, but what can you do with it?" "Can you deliver a variety of weapons?" "Can you hit both ground and air targets?" "Are you capable of air to air refueling?" "What about range?"

To answer these and other questions and to correct the many misconceptions that seem to exist regarding the tactical capability of the 104 Starfighter, let us explore some of the missions performed daily by the 479th Tactical Fighter Wing at George AFB.

It is well known that the 104 is easily capable of Mach 2 and beyond and is the present holder of the "Triple Crown" - records in

Speed, Altitude and Time to Climb. These records were all set in the 104A. Our C model is an improved version with a better engine and all around superior performance. Now let's take a look at what's been going on since we received our first aircraft at the 1958 Gunnery Meet in Las Vegas.

Actual figures and times are, of course, classified but the entire Wing has transitioned smoothly into the bird. First check-outs were in the C model and as our two place D's became available, one or two rides were given in the D before solo in the C. No pilot suffered any difficulty in the check-out phase. Experience level varied from four hundred to six thousand hours and pilots were transitioned from aircraft ranging from the T-Bird to the Super-Sabre and even some Navy types. Extreme simplicity of cockpit layout and procedures combined with excellent visibility from the rear seat of the D make this an instructor's dream. The traffic pattern and landing have been discussed in other articles—suffice it to say that the aircraft lands as easily as a T-Bird and with a very short landing roll. Fantastic speeds are definitely not a part of the landing phase!

Now that we have our jock checked out, what do we do with him? As in any other tactical fighter, we put him into a program to make him a combat ready crew. All pilots undergo intensive training in air to ground delivery with both conventional and nuclear weapons. Aerial gunnery is flown on both banner and Dart targets and all pilots fire the GAR-8 Sidewinder. Radar and sight presentation to the pilot is excellent. The pilots end of the radar or the cockpit controls are compact and easy to operate. Infra-red makes night kills quite feasible and scope presentation is clear enough for the novice to get the hang of it quickly.

Refueling is simplicity itself. The probe is located to the left and slightly ahead of the cockpit, easily within the pilots vision. No blind stabbing and cussing at a drogue you can't see—just fly it in. Instant power and control response make this a "no sweat" operation.

Many of the un-informed have been critical of the short range of the 104. This just is not so! Naturally, we cannot go from coast to coast at Mach 2 in afterburning without refueling. No present day fighter can. Range varies with configuration and with power settings as in any other aircraft. Actual figures can be found in the Confidential Supplement to the Dash - 1 and if you are interested enough to research them, they will probably surprise you!

To conclude—the tactical missions that can be performed are not in the planning stage nor are they things we think can be done; all <u>are</u> being performed here daily. The 104 is ready and capable to deploy <u>anywhere, anytime</u> and assume <u>any</u> mission, air to air, air to ground, area defense of troop transport (one per cockpit)!

The TAC Test Program

By: Lt/Col. A. M. Aust, Jr.
Chief Operational Test and Evaluation Division (TAC)

During August 1958, USAF Headquarters revised the regulation covering the research and development testing program. Previous to this time all testing was accomplished by the various ARDC Centers, but this testing program did not keep up weapons systems being delivered to the using commands. Some commands had already established test units to be assured that equipment being procured met their requirements, or to obtain information that had not been provided by ARDC. The new AFR 80-14, as written, required the using commands to enter the testing program as early as possible. The new testing program did away with the phase type testing and used three type categories instead. Category I type testing would be joint testing accomplished by the contractor and ARDC. Category II testing is accomplished jointly by ARDC and the using command, with the contractor assisting where required. Category III testing is accomplished by the using command with ARDC and the contractor looking on and assisting when required.

For major weapon systems, a joint test will be completed by ARDC and the using command beginning with Category II. Normally the using command will own the weapons system and will maintain it during the testing phase. This method provides the command with a combat ready unit at an early date and also allows the command a chance to gain test experience. This also provides the command with a chance to make changes as required to meet established goals previously established for the weapon system.

For components and support items, the command does not enter the test program until Category III. Prior to actually testing an item ARDC provides TAC with certain information as the development of the item progresses. Development and functional test reports are forwarded to TAC for review and information. During functional testing or at the completion of functional testing, ARDC will ask the using commands to approve a status classification for the item being tested as required by AFR 80-6. Prior to this time TAC has already decided whether an operational test is required, and TAC will prepare ARDC Form 81D stating recommendation for classification action and whether a test will be completed or not. Normally a test will be completed on any item that could affect the combat capability of an operational unit.

The TAC test program was established in February 1959 and four TAC regulations in the 80 series have been issued to cover all testing to be accomplished by TAC units. An Operational Testing and Evaluation Division was established within the Directorate of Requirements under the Deputy for Operations. The OT&E Division has test personnel attached to the 837th Air Division at Shaw AFB, S. C., 831st Air Division at George AFB, Calif., and the TR&D Section at Nellis AFB, Nevada. At TAC Headquarters the OT&E Division has a Chief, an Operations Officer, a Materiel Officer, an Electronics Officer, an Armament Officer, and an administrative section consisting of three people. At the 837th Air Division three test supervisors are attached to cover photographic equipment (moving and still), photo reconnaissance equipment (RF-101 and RB-66), and electronics equipment (both ground and airborne). At the 831st Air

Division, one test supervisor is attached to cover equipment being tested for the F-104 aircraft. At the TR&D Section at Nellis, one test supervisor is attached to assist with equipment being tested for the F-100. The TR&D Section also assists in the development of tactics and techniques for all fighter weapon systems being used by the Tactical Air Force.

The OT&E Division is also responsible for the joint tests being accomplished by TAC and ARDC. Example of these are the F-105 joint test, the 212L Tac Control System, the TM-76A Category III test, and others to get underway at a later date. Normally TAC will appoint a test force to accomplish the joint test with ARDC. This type test may be accomplished at either an ARDC or a TAC site.

Each TAC numbered air force has appointed an operations officer and a maintenance officer to monitor the test program. Ninth and Twelfth Air Forces provide operational and logistical support for test projects assigned. Normally the OT&E Division coordinates with the numbered air force representative prior to assignment of a test project. In most cases tests are assigned to either Shaw, George or Nellis Air Force Bases. It may be necessary at times, however, to assign projects to other bases.

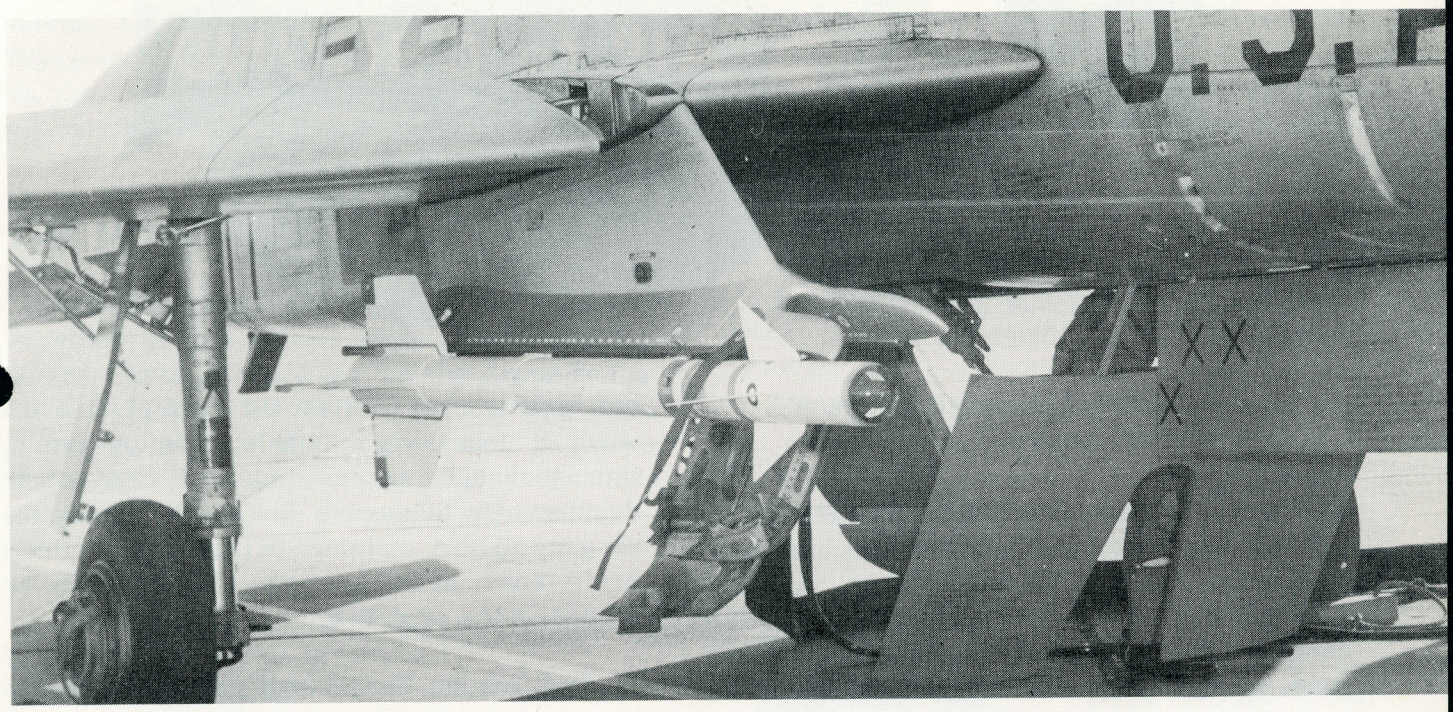
In such cases coordination and approval is received from the air forces and wing concerned prior to actual project assignment. In these cases, also the test supervisors assigned to OT&E will be made available to the test site to assist in establishing the project, writing the test order supplement, etc. Once the test site has been established a test order is prepared in draft form for coordination. The test order includes background material, a description of the test item, the purpose and scope of the test, a method of conducting the test, the resources available, outlines responsibilities for certain units, establishes target dates and priority for the test, outlines security procedures to be followed, and covers reports that are required during the testing process. The test order is coordinated with the responsible staff agencies. Comments and recommendations provided by the individual agencies are included in the final draft prior to publication and distribution. All test orders are reviewed, approved, and signed by the Deputy for Operations prior to publication.

The test order is normally published prior to receipt of the test item to allow the selected test unit sufficient time to plan the actual test program. Distribution of the test order is made directly to the units designated responsible for certain phase of the test. By using this system, the paper work is reduced for the numbered air forces and air divisions. These units will monitor the program through review of weekly progress reports or with direct contact with the project officer or test supervisors. The test supervisors and project officers will complete planning as required for each assigned test project.

The project officer submits weekly progress reports to the various agencies as outlined by TAC Regulation 80-1. This report, when properly used, provides each agency with a word picture of what has been accomplished and the difficulties encountered since the last report. At the completion of the test, a final report is prepared by the project officer and the test supervisor in draft form. The draft copy is forwarded to TAC for review, coordination, final typing, approval, printing and distribution.

TAC Regulation 80-2 outlines the TAC test program and it also outlines procedure whereby a unit or individual can forward ideas for establishment of a test project. All such ideas are reviewed and researched by the Test Division to determine whether a test has already been accomplished and if not, what can be gained from such a test. Personnel in the operational units really come up with some fine ideas. Normally, when enough thought has been put into a project to write it out and forward it to TAC, it is worth establishing a test project. This statement should not infer that all proposed test projects or ideas are not carefully investigated prior to approval.

WEAPONS



- Air to Ground, Century Style
- Elusive Dart
- Combat Profile
- Preflight Planning for Turns
- LABS Gyro Mod
- New Gyro Leveling Fixture
- Quiz
- GAR 8 Tactics
- Temperature vs Infrared
- Quick, Dirty and Cheap
- Dart Tow Cable Mod

SECTION II

By: Captain Michael G. Filliman
TR&D Section

There has been a gradual re-awakening of interest in conventional weapons and their associated delivery in the past few months. Lebanon and Formosa may have been the catalysts. Since National Policy may, at some time, dictate the use of conventional weapons in lieu of atomizing or vaporizing targets, we must be prepared. The following article is written for the purpose of supplying the pilot in the field, with enough information to enable him to plan and practice for conventional delivery. Even if little or no time is allotted for conventional delivery practice, a pilot can use this information as a guide or foundation upon which to build. The suggested methods and crutches offered in this article, for determining and arriving at release conditions, are for training purposes only. No system, method or crutch can replace the tried and true combat technique of "adjust the sight picture and when it looks right, pickle." Unfortunately, this technique takes time and practice to develop. Crutches are invaluable during the up-grading or training period. As a pilot's proficiency develops, less reliance can be placed on the crutches.

The article deals with four types of delivery; Low Level Bomb (Napalm), Strafing, Rockets, and High Angle Bombing. Each type delivery will be discussed from three viewpoints; Training delivery, Pilot techniques, and Combat delivery considerations. The latter is not to be construed as initiation or revision of tactical doctrine, but only as guidelines for planning. Training deliveries outlined are the recommended procedures of the USAF Fighter Weapons School, currently being used in the Weapons Instructor's Course. These supersede the earlier procedures and patterns outlined in TR&D Project 57-9B-"F-

100D/F Air-to-Ground Evaluation." AFM 335-25 (which is now in the process of being revised) contains more detailed information on delivery of these weapons. It is a valuable aid for those involved in computation and origination of delivery methods and procedures. Chapter Nine of 335-25 - "Fighter Weapons Qualifications" has been re-written in the form of an AF Regulation. Generally, the qualifications have been lowered.

LOW LEVEL BOMB - (NAPALM)

Low level bomb and napalm are considered together in this article since the present day concept is to practice for napalm drops by low level bombing with practice bombs. Low level bombing, with hard case weapons, requires the same techniques as napalm drops and, therefore, will not be discussed separately.

A. Training Delivery

Pattern

1. Figure 1 illustrates a realistic training pattern. The reasoning for the selected airspeed and altitude will be discussed in Section C.

2. Sight Setting: Since sight settings differ with aircraft type and type of harmonization, only the depression (in mils) from flight path for each bomb, for the pattern above, will be given:

25# Bomb (free fall rack) = 45 mils from flight path

25# Bomb (MN-1 Dispenser) = 56 mils from flight path

M-116 Napalm Tank = 48 mils from flight path

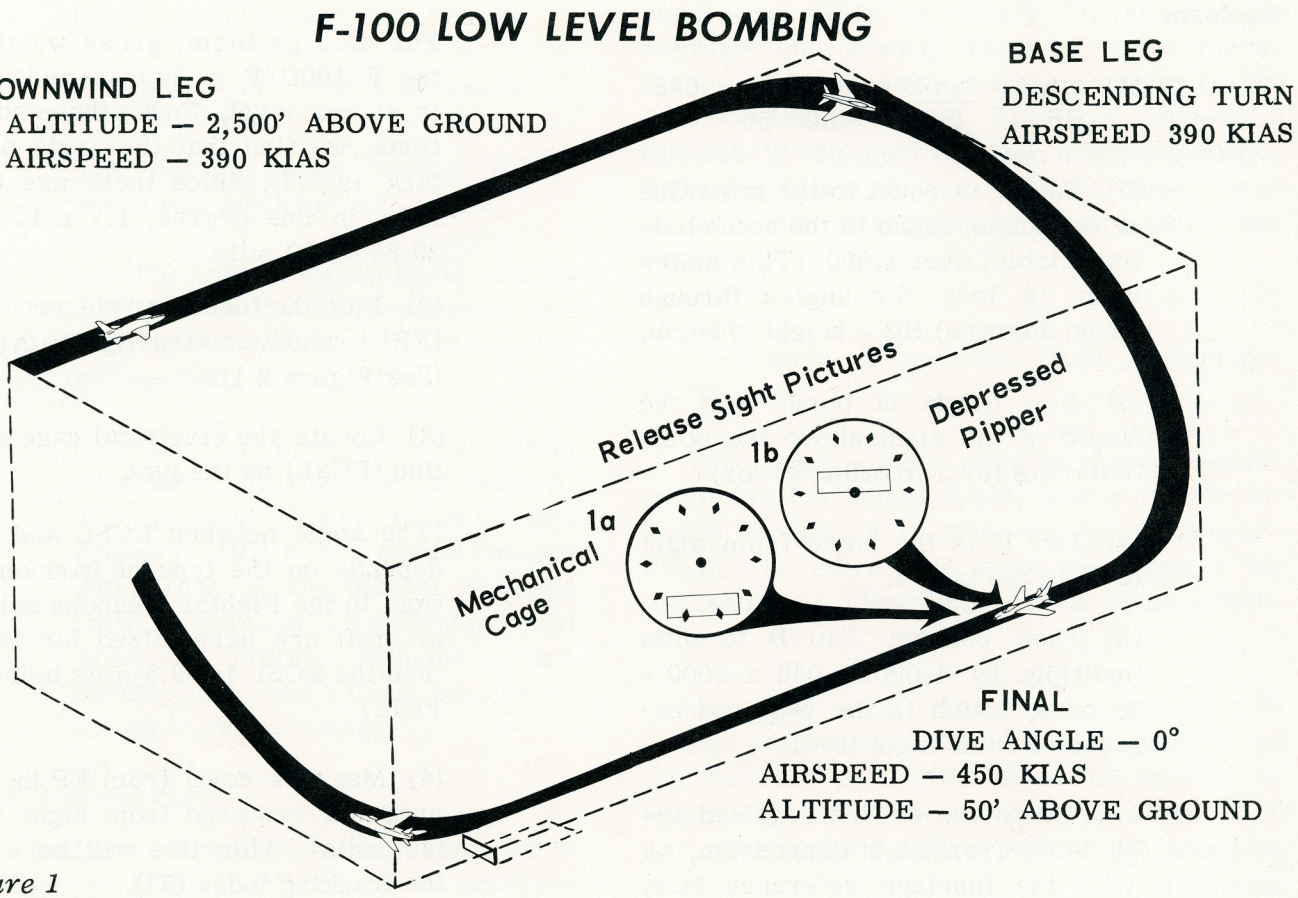


Figure 1

As shown in the following example of an F-100D/F Napalm sight setting computation, this depression must be oriented with the sight line.

a. Release conditions:

450 KIAS and 50' above target (horizontal flight) Sea level

(450 KIAS = 459 CAS - 459 TAS)

b. Enter class "C" bomb ballistic tables (AFM 335-25) and obtain required depression for release conditions. (43 mils)

c. It is necessary to determine depression required from flight path at sight level because there is a vertical displacement (6') between the height of sight and the height of the bomb. This is done by using the following formula:

(1) $\frac{\tan A}{HB} = \frac{\tan B}{H}$ or $\frac{043}{50} = \frac{X}{56} = .048$

(2) Tan A is equal to the mil value of the angle, found in the bomb ballistic table, over 1,000. (This statement is true for angles through seven degrees) HB - height of bomb.

(3) H = height of bomb plus the height of the sight above the bomb (corrects for a parallex error)

(4) Tan B is the angle from sight level to the target.

(5) Then convert Tan B to mils (multiply by 1,000). .048 x 1000 = 48 mils, which is the required depression from sight level.

d. In order to convert the required depression (48 mils) from sight depression, we orient it with the fuselage reference line, flight path and sight line in the following manner. (See Figure 2.)

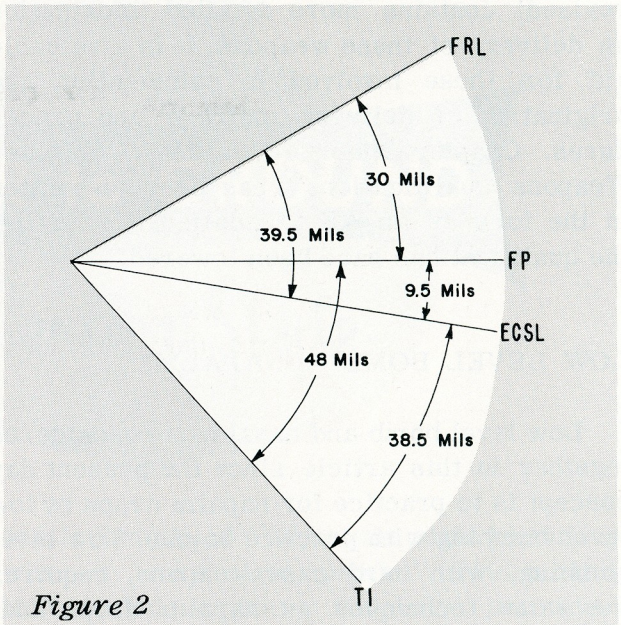


Figure 2

(1) Determine the angle of attack of your aircraft from a nomogram:

For this problem, gross weight of the F-100D/F is 28,000# and target is at sea level. Under these conditions, we find that the angle of attack is 1.7°. Since there are 17.45 mils in one degree, 1.7 x 17.45 = 29.66 or 30 mils.

(2) Plot the fuselage reference line (FRL) relative to the flight path (FP). (See Figure 2.)

(3) Locate the electrical cage sight line (ECSL) on the plot.

(The angle between ECSL and FRL depends on the type of harmonization. In the Fighter Weapons School, aircraft are harmonized for 1400'; thus the ECSL is 39.5 mils below the FRL.)

(4) Measure down from FP the depression required from sight level (48 mils). This line will be called the tracking index (TI).

(5) The angle between the electrical cage sight line (ECSL) and the tracking index (TI) will be the radius of the fixed sight reticle (38.5 mils in this case).

(6) Use this formula:

$$\frac{\text{Wing Span}}{\text{Range Drum}} = \frac{\text{Reticle Diameter}}{1000}$$

to determine the wingspan setting that will give the desired reticle size. In this formula, there are three knowns:

Range Drum - (the reading on the range dial). Since we are using mechanical cage sight, it will be 600'.

Reticle Diameter - twice the angle between ECSL and sight line (2 x 38.5 mils 77 mils).

1000' (constant for this formula)

$$\frac{\text{Wingspan}}{600} = \frac{77}{1000} = 46.2 \text{ Wingspan}$$

The correct sight setting is 46' wingspan, mechanically caged.

(7) The angle between ECSL and the TI (38.5) is the mil depression required when using a depressed pipper method.

(8) The sight picture for release is illustrated in Figures 1a and 1b. The pipper, Figure 1b (with depressed VRDU) is a better release index than is the bottom diamond (with Mechanical Cage Sight method) when the bottom diamond is not exactly at the six o'clock position in the sight reticle image.

B. Pilot Techniques

1. Delivery—The first requirement for a good low level bomb delivery is an accurate run-in. The run should be started at the maximum range that terrain and target visibility will allow. The release airspeed should be established at the start of the run, so that only small throttle movements will be required. Level flight, at the desired release height, must be established as soon as possible during the run-in. The sight picture is not a primary consideration during the early portion of the run-in, instead, emphasis is placed on maintaining correct airspeed, altitude, level flight and making cross wind corrections. Cross wind is corrected for by crabbing into the wind so that the aircraft's flight path will be directly over the target. A "rule of thumb" correction for wind is 2 mils per MPH of cross wind. The elimination of cross wind may cause the tracking index to be offset from the target, but this does not prove to be a problem in determining release point. The bomb release point must be anticipated during the last few seconds as the tracking index approaches the target. In turbulent air conditions, it is necessary for the pilot to average out erratic tracking index movements and, in this manner, anticipate the correct release point. This last portion of the run is the most critical, since a tendency exists to climb or dive slightly, resulting in an untimely release sight picture and range errors.

2. Effects of deviation from planned delivery.

Dive angle - Since sight settings are computed for horizontal flight, a dive by the delivery aircraft will cause the bomb to overshoot. The more dive angle, the greater the overshoot. A climb will result in an undershoot.

Airspeed - A change in airspeed will change the shape of the bomb's trajectory and the delivery aircraft's angle of attack. An overspeed condition will cause overshoot and an under speed condition will result in undershoot.

"G" loading - A change in the angle of attack of the delivery aircraft due to "G's" will affect effective sight depression. If the tracking index (pipper or bottom diamond) is on the target at release, positive "G" (more than 1 "G") will result in undershoot and negative "G" (bunt) will result in overshoot.

Skid - If the delivery aircraft is in a skid, the bomb trajectory will not be through the tracking index, but will fall along the actual flight path.

Altitude - This is the most critical constant in low level bombing, since the sight depression is computed for only one altitude. If the delivery aircraft is too high, the bomb will undershoot, and conversely, if the aircraft flies lower than planned, the bomb will overshoot.

C. Combat Delivery Considerations.

1. Airspeed - The general pattern of combat delivery airspeeds since the inception of the aircraft as a weapons system has been "go as fast as full blower takes you." With the century series however, we have arrived at a state of the art where "full blower" is too fast - too fast for acceptable accuracy. A compromise must be made between a slow, very accurate, but vulnerable, airspeed and a relatively safe, yet inaccurate, velocity. For napalm delivery with the F-100, this compromised delivery airspeed is in the area of 400 to 450 KIAS.

2. Altitude of delivery - Fifty feet is about the dividing line between acceptable and unacceptable accuracy limits when a pilot has no reference for altitude other than "eyeball" estimation. Higher altitudes also result in unacceptable lateral errors on small targets.

3. A USAF Fighter Weapons School, TR&D Project 58-13, provides additional information on napalm tanks, their construction and delivery procedures.

STRAFING

Strafing is the technique of delivering a gun attack against surface targets. Accuracy against even small targets is excellent with a low angle delivery and is the selling point for strafing.

A. Training Delivery

Pattern

1. Figure 3 illustrates a realistic training pattern. The reasoning for the selected airspeed, dive angle and slant range will be discussed in Section C.

2. Sight Settings - If firing at or near the harmonized slant range and airspeed (if a harmonized airspeed exists) there is no requirement for computation of a sight setting. The pipper is used as the tracking index in either mechanical caged or electrical caged function.

B. Pilot Techniques

1. Delivery - Strafing is the easiest type of conventional delivery to master since deviations from a planned maneuver result in less impact error than in any other type delivery. Considerable variances in airspeed and dive angle are possible without detracting seriously from accuracy. The major problem in strafing is holding the pipper steady while firing. The longer the burst, the more difficult this problem. The best technique for strafing is to use a base leg to insure a planned dive angle and airspeed. The use of the base leg, however, is not nearly as important as in other weapon deliveries where airspeeds and dive angles are more critical. In combat, for example, a straight-in approach with a slight push over may be a more desirable method. The "rule of thumb" wind correction for strafing is 1/2 mil per MPH of wind. Firing in a cross wind can be accomplished in two ways: fly wings level and use rudder to hold the pipper on the upwind aim point, or bank

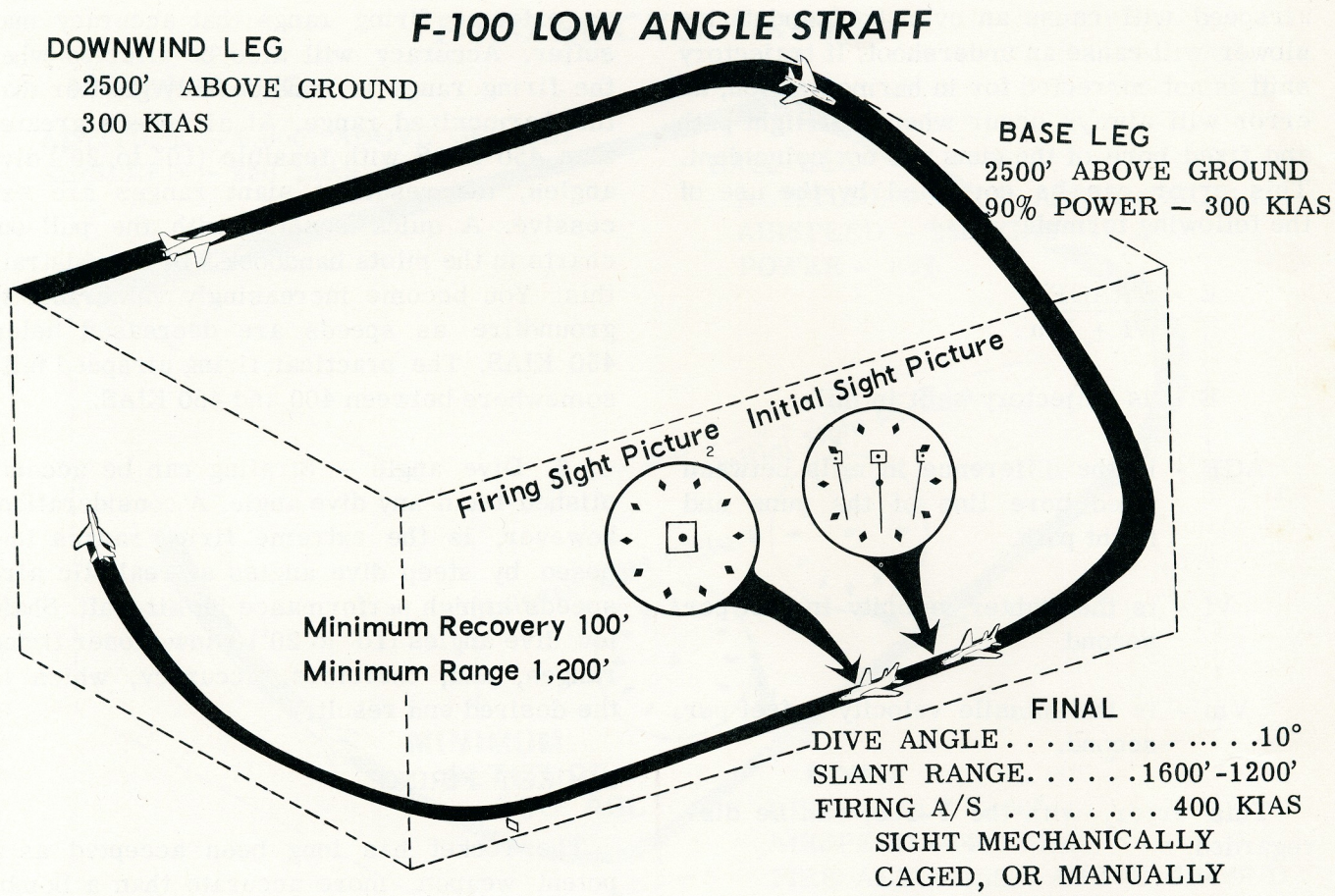

F-100 LOW ANGLE STRAFF
DOWNWIND LEG
2500' ABOVE GROUND
300 KIAS
BASE LEG
2500' ABOVE GROUND
90% POWER – 300 KIAS
Firing Sight Picture 2
Initial Sight Picture
Minimum Recovery 100'
Minimum Range 1,200'
FINAL
DIVE ANGLE . . . . . .10°
SLANT RANGE. . . . . .1600'-1200'
FIRING A/S . . . . . 400 KIAS
SIGHT MECHANICALLY CAGED, OR MANUALLY RANGED TO 1,000' AND ELECTRICALLY CAGED

Figure 3

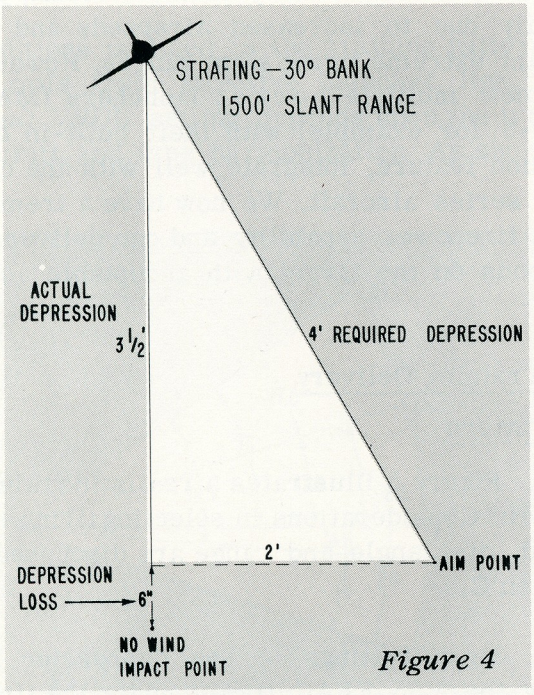


Figure 4

into the wind and use rudder to hold the aim point. While firing in a bank, errors are negligible, as shown in Figure 4. This latter technique may be especially suitable in combat, where targets may be moving and/or winds are not known.

2. Effects of deviations from planned delivery.

Dive angle - Since an aircraft is harmonized straight and level, firing in a dive induces a slight overlead. The steeper the dive, the more overlead, however, in practical usage, this error can be disregarded.

Airspeed - The effects of airspeed in strafing is determined by the type of harmonization used. If trajectory shift is corrected for in harmonization, the aircraft has a harmonized airspeed. Firing faster than this

airspeed will cause an overshoot and firing slower will cause an undershoot. If trajectory shift is not corrected for in harmonization, an error will always occur when the flight path and fixed bore of the guns are not coincident. This error can be computed by the use of the following formula:

$$E = \frac{Vf(AGF)}{Vf + Vm}$$

E - is trajectory shift in mils

AGF - is the difference in mils between fixed bore line of the guns and flight path.

Vf - is the fighter velocity in feet per second.

Vm - is the missile velocity in feet per second.

This error, with the F-100, can be disregarded.

Slant Range - The effects of firing at ranges other than the harmonized range vary with aircraft type and type of harmonization. As a general rule, firing at ranges other than the harmonized range results in an undershoot.

"G" loading - Positive "G" loading (while tracking the target) will result in undershoot while negative "G" loading will result in an overshoot.

Skid - Firing in a skid will cause the impact point to be diverted from the aiming point toward the flight path. The trajectory shift formula can be used to compute the error, however it is small and can be disregarded.

C. Combat Delivery Considerations.

1. Airspeed - Firing airspeed is directly proportioned to firing range in a strafing attack. A safe, high airspeed may require such an extreme firing range that accuracy may suffer. Accuracy will also be affected when the firing range is considerably greater than the harmonized range. At airspeeds greater than 450 KIAS with feasible (10° to 20°) dive angles, the resultant slant ranges are excessive. A quick session with the pull-out charts in the pilots handbook will demonstrate this. You become increasingly vulnerable to groundfire as speeds are decreased below 450 KIAS. The practical firing airspeed falls somewhere between 400 and 450 KIAS.

2. Dive angle - Strafing can be accomplished from any dive angle. A consideration, however, is the extreme firing ranges imposed by steep dive angles at realistic airspeeds in high performance jet aircraft. Shallow dive angles (10° to 20°) allow closer firing ranges, and, therefore, accuracy, which is the desired end result.

ROCKET FIRING

The rocket has long been accepted as a potent weapon, more accurate than a bomb, more powerful than a gun. The single rocket's accuracy, however, is not satisfactorily compatible with our century series aircraft, primarily due to increased airspeeds and resultant extreme firing slant ranges. However, the new multiple rocket launchers (MA-3, LAU-3 for example) with their built-in dispersion feature, integrate well with the century series aircraft. We now have a tremendous firepower capability and can deliver the weapons on the target with acceptable accuracy.

A. Training Delivery Pattern

1. Figure 5 illustrates a realistic training pattern. Considerations in selecting firing airspeed, dive angle and range are discussed in Section C.

2. Sight Settings - The depression for firing the 2.75 FFAR rocket under the firing

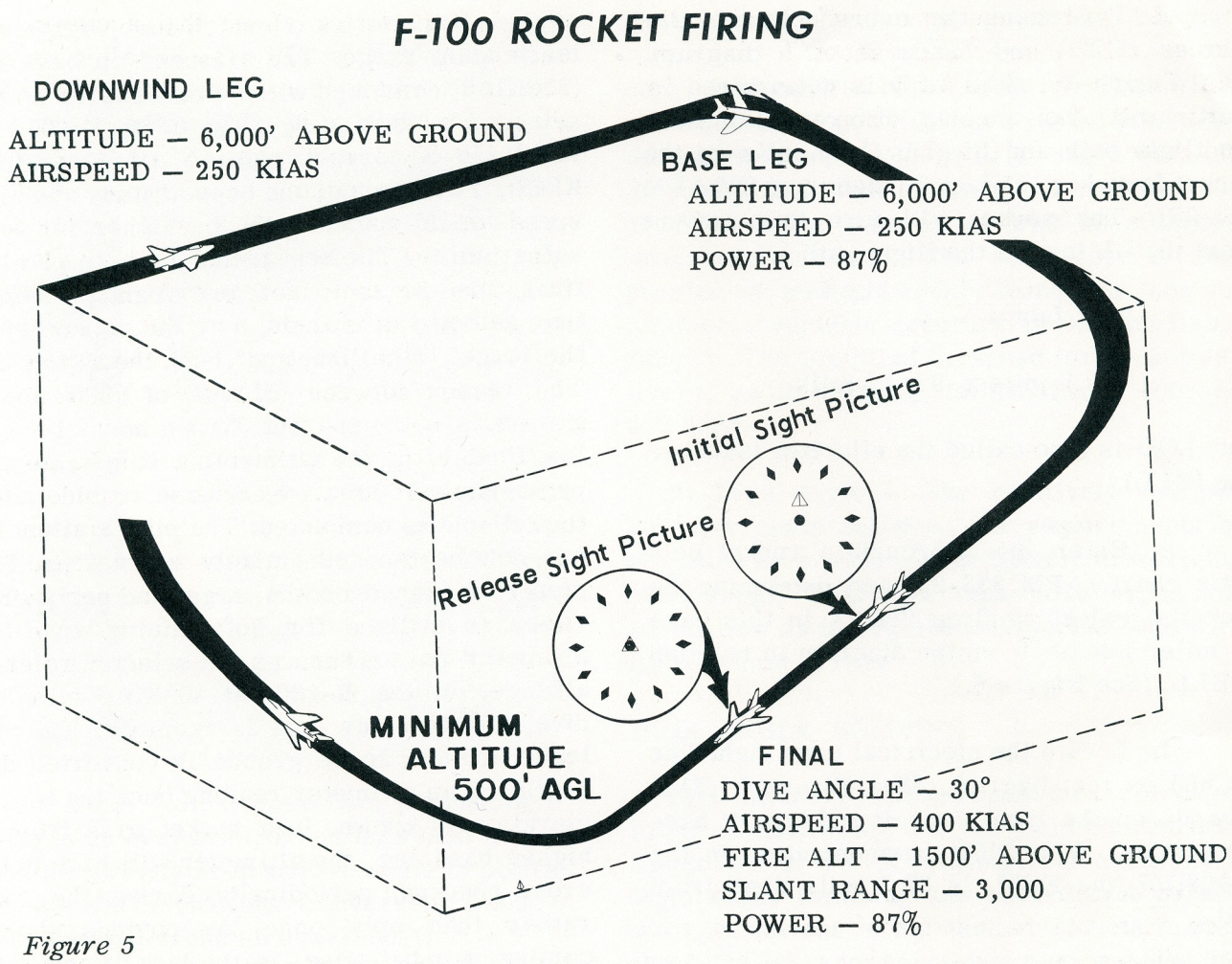


Figure 5

conditions outlined in the training pattern, is 20 mils from effective launcher line. The actual VRDU setting depends upon the type of aircraft and type harmonization. As shown in the following example of the setting computation for the F-100D/F, this depression from effective launch line must be oriented with the sight line.

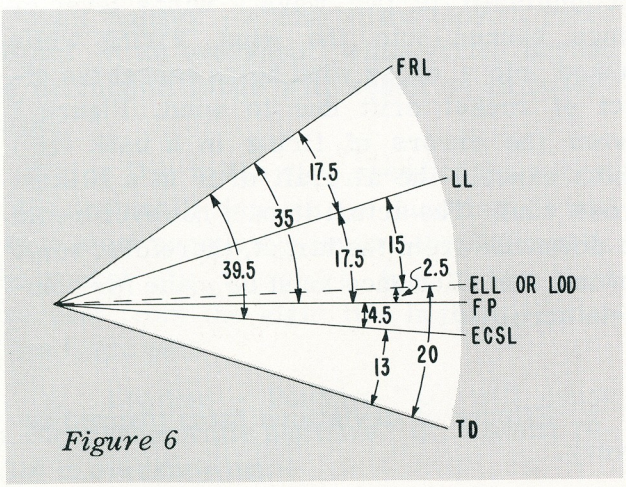


Figure 6

a. Firing conditions - 400 KIAS (409 CAS - 438 TAS) 4500' Ind. Standard Day - 3000' slant range - 30° dive.

b. F-100D/F Angle of Attack - 2° (28,000# gross weight) - 34.9 (35) mils. Locate the flight path (FP) in reference to the fuselage reference line (FRL). (See Figure 6.)

c. Locate the launcher line (LL). This is one degree (17.5 mils) down from FRL in the F-100 (listed in the applicable aircraft armament systems Tech Order).

F-100 HIGH ANGLE DIVE BOMBING

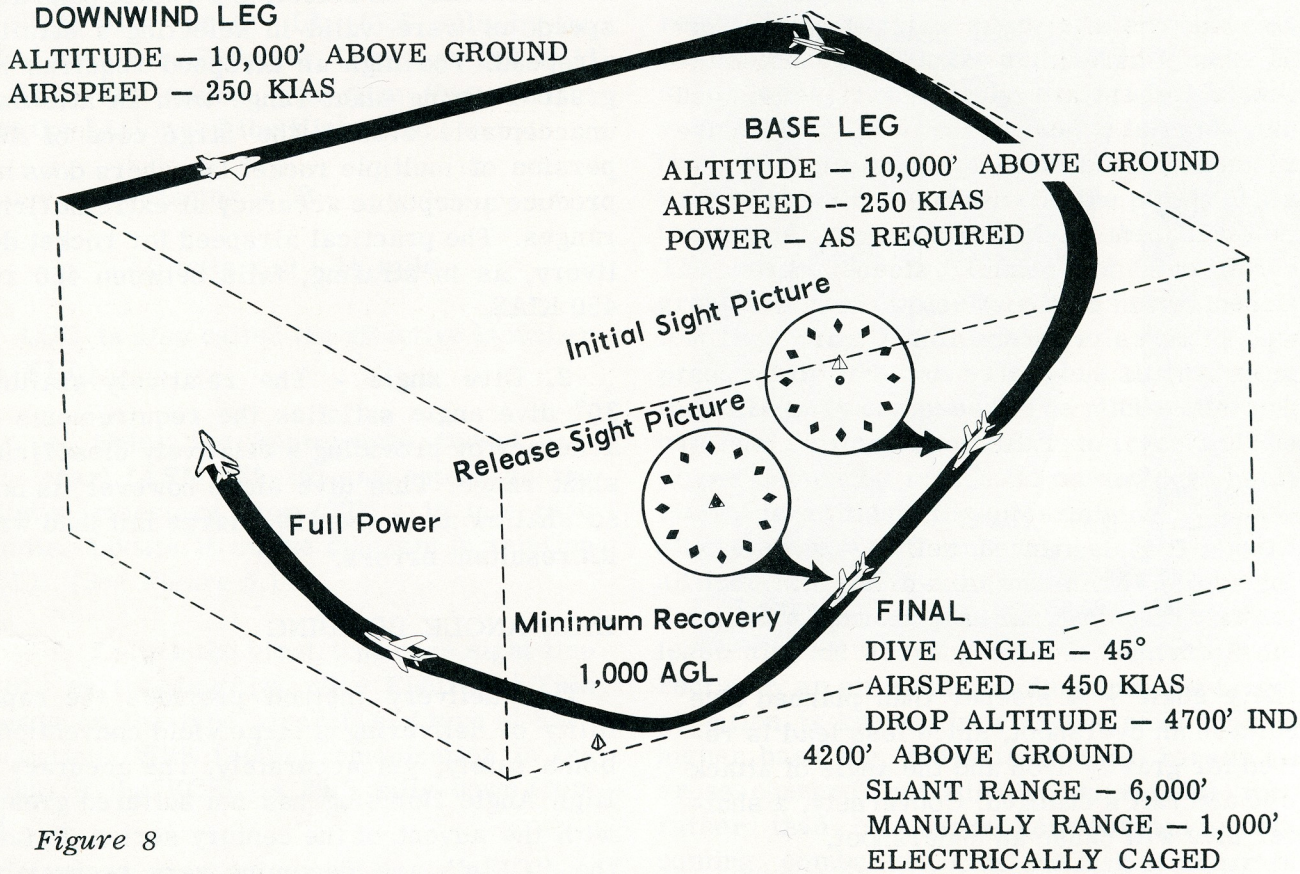


Figure 8

this depression must be oriented with flight path and sight line.

a. Release conditions: 450 KIAS - 459 CAS - 500 TAS-45° dive - 6,000' slant range.

b. Depression required - 88 mils (Class "C") bomb ballistic tables AFM 335-25. These tables are computed for sea level conditions, therefore, TAS must be used instead of CAS when entering the bomb tables.

c. The F-100D/F angle of attack for 28,000# gross weight is 21 mils. Locate the flight path (FP) in reference to the fuselage reference line (FRL). (See Figure 9.)

d. Locate the trajectory drop (TD) of the bomb - 88 mils down from flight path. (See Figure 9.)

e. Locate the electrical caged sight line (ECSL). (See Figure 9.) This depends on the type aircraft and harmonization. With 1400' harmonization in the F-100D/F, the ECSL is 39.5 mils down from FRL.

f. The angular difference between ECSL and TD (69.5 mils) is the required VRDU setting. (See Figure 9.)

B. Pilot Techniques

1. Delivery - As in rocket delivery, for training, crosswind, downwind and base legs are flown. For combat high angle bombing, a base leg only would be used. The base leg, as mentioned previously, is an invaluable aid in arriving at a planned dive angle on final approach. Criticality of dive angle is extremely high in dive bombing. The base leg altitude

and airspeed would probably be increased for combat above these listed here however. The altitude selected for the training pattern places the delivery aircraft within 1,000' of the release altitude after a normal roll-in, roll-out and sight picture adjustment. This enables the pilot to concentrate on sight picture and use only peripheral vision for judging when the altimeter passes through the release altitude. (4,700' above ground with 500' altimeter lead). The final turn should be flown so as to arrive at roll out in a slightly steeper dive than planned, with the pipper below the target (see sight pictures illustrated in Figure 8). The pipper should be placed on the target just prior to reaching release point. Wind drift of the delivery aircraft presents the biggest stumbling block to accuracy. The bomb must be delivered wings level, since errors resulting from a banked delivery are gross (Figure 10). From the wind drift viewpoint, a shorter time on final is advantageous when wind values are now known. With accurate wind information, in a training situation, an offset roll-out and release point can be calculated and accuracy will improve (rule of thumb for wind—two mils per MPH). In a combat type situation where target elevation and wind information are lacking, high angle bombing presents a serious challenge to the average pilot.

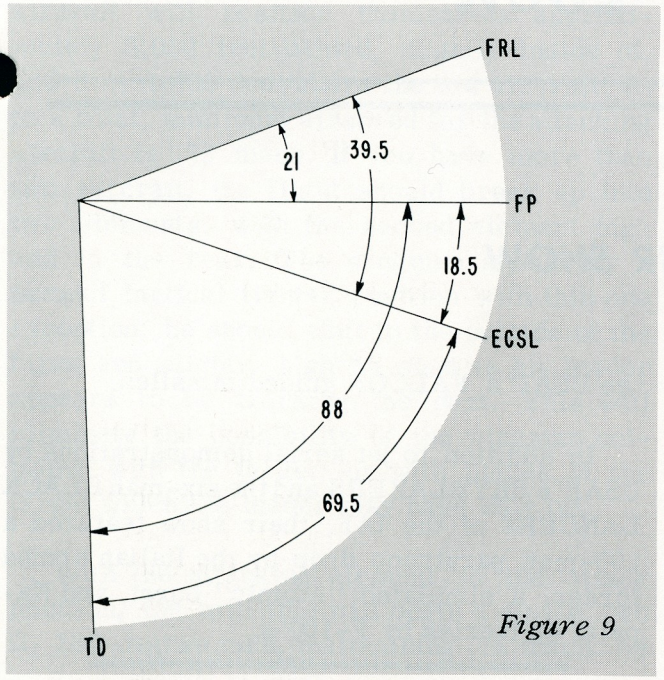


Figure 9

2. Effects of deviations from planned delivery.

Dive angle - The most critical constant in a delivery is the dive angle. A steeper dive results in an overshoot, a shallower dive (more common error) results in an undershoot.

Airspeed - An overspeed delivery will result in an overshoot and, conversely, underspeed will result in an undershoot, this is due to the fact that airspeed affects the shape of the bomb trajectory and also changes the angle of attack of the aircraft.

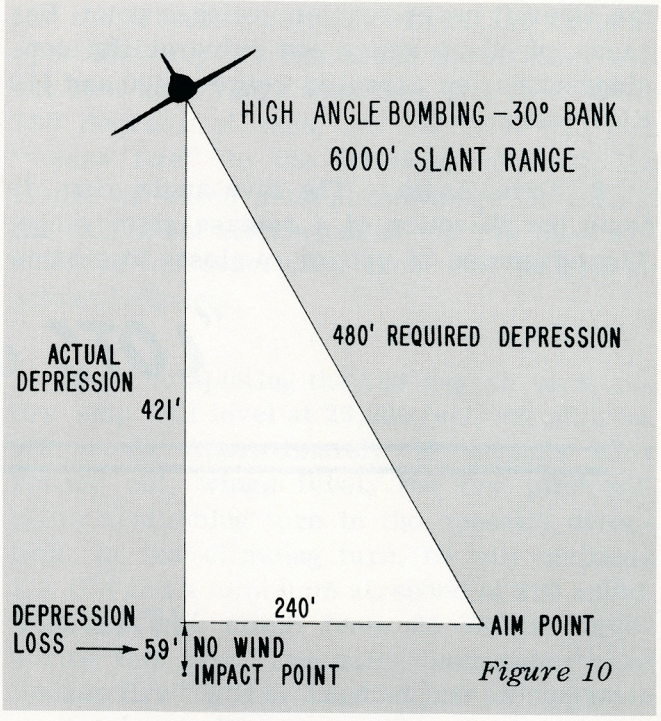


Figure 10

Slant Range - Since the depression required and utilized in a sight setting is predicated on only one range, being closer than planned at release will cause an overshoot and being beyond the planned range will cause an undershoot.

"G" Loading - Increasing the "G" loading on the aircraft causes an increase in the angle

of attack and therefore, a decrease in effective depression with a resultant undershoot. Negative "G" will result in overshoot.

Skid - The result of a skid, at release point, is a miss. The bomb will not fall through the sight line but will fall in line with the flight path of the aircraft. The effects of skid error are greater in high angle bombing than in any other type of delivery discussed.

C. Combat Delivery Considerations.

1. Airspeed - The same problems, in the selection of a release airspeed, are present in high angle bombing as are found in any diving delivery. Too high an airspeed results in too great a slant range for acceptable accuracy. Too slow an airspeed may result in the aircraft never reaching release point. Because of slant range and vulnerability considerations, an airspeed between 400 and 450 KIAS looks good.

2. Dive Angle - The dive angle also affects the selection of a release slant range. The advantage of getting in closer at shallow dive angles does not overcome the increase in range error with a given dive angle deviation. On the other hand, a 90° dive is ideal for accuracy, but is impractical. Even dive angles in the region of 60°, while inherently accurate, are uncomfortable, while working close to the ground. A 45° dive seems to be a happy medium.

CONCLUSION:

1. A vital aspect of training, not previously mentioned, is film assessing. A vigorous film assessing program will improve training accuracies by enabling a pilot to see and correct deficiencies in his deliveries. He will not tend to blame sight settings, winds, etc., entirely, for gross errors. The procedures for setting up a film assessing program are outlined in AFM 335-25, page 332.

2. Conventional weapons and their delivery will remain with us for as long as we have fighters. They will remain for the same reason that policemen still carry guns instead of small A-bombs.

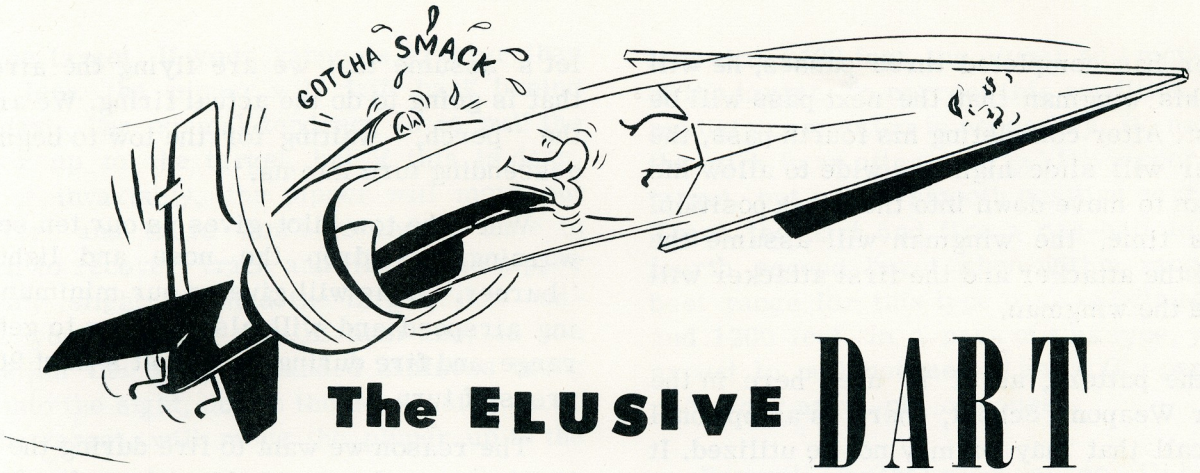
"LOTS of LUCK"

ITALIAN AIR SHOW

MYRTLE BEACH, AFB, S.C. . . . The 355th Tactical Fighter Squadron, on temporary duty at Aviano AB, Italy, participated in the largest aerial demonstration ever performed in the Italian skies on Sunday, June 28.

Staged by U.S. and Italian Air Force officials, the big show exhibited publicly for the first time in Italy, the IAF's NIKE-AJAX and the USAF's FALCON guided missiles.

In addition to jet aerial demonstrations by USAF's SKYBLAZERS and the six-man BLACK LANCERS of the IAF, their show featured a 100-man paratroop drop by the Italian armed forces, a simulated "atomic" burst, and Napalm deliveries by F-100's.



The ELUSIVE DART

By: Captain Robert M. Bond
O&T Section

Hitting the dart consistently is a lot like sex—there are some fundamental things that have to be done, and after that, it's all technique.

This article contains an outline of the dart pattern, as flown here at Nellis by the Fighter Weapons School, and some technique tips to improve your scores against this elusive target.

The pattern begins with the tow ship at 30,000 feet, indicating .75 mach. The firing aircraft will position themselves approximately 5,000 feet behind, slightly inside of, and 3 to 4,000 feet above the tow aircraft. At this point, minimum airspeed for the attacking aircraft is .75 mach. If you have more than two aircraft, the flight should break up into two elements, with the second element high and to the rear. The wingman should fly a normal tactical fighter position with this one exception; he should shift to the outside of the turns and slightly high as soon as his leader appears to be tracking the dart. This will eliminate the possibility of the wingman colliding with the target, or with pieces of the target which his leader may have shot off.

With the attacking element in the attack position, the tow ship will begin a diving, two G, 180 degree turn, maintaining .75 mach. As the tow pilot begins this turn, he will call "commence fire" to the attacking element. The firing aircraft will acknowledge this call and will then be cleared to fire anytime on the descending 180 degrees of turn. The only restriction is that the minimum firing airspeed for the attacking aircraft will be 380 knots or approximately .92 mach, and the attacker will not fire at a range less than 800 feet. After 180 degrees of turn, the tow pilot will call "cease fire" to the attacking element, the leader of which must acknowledge the call. If the call is not acknowledged, the tow pilot will continue his descending turn until he gets an acknowledgment.

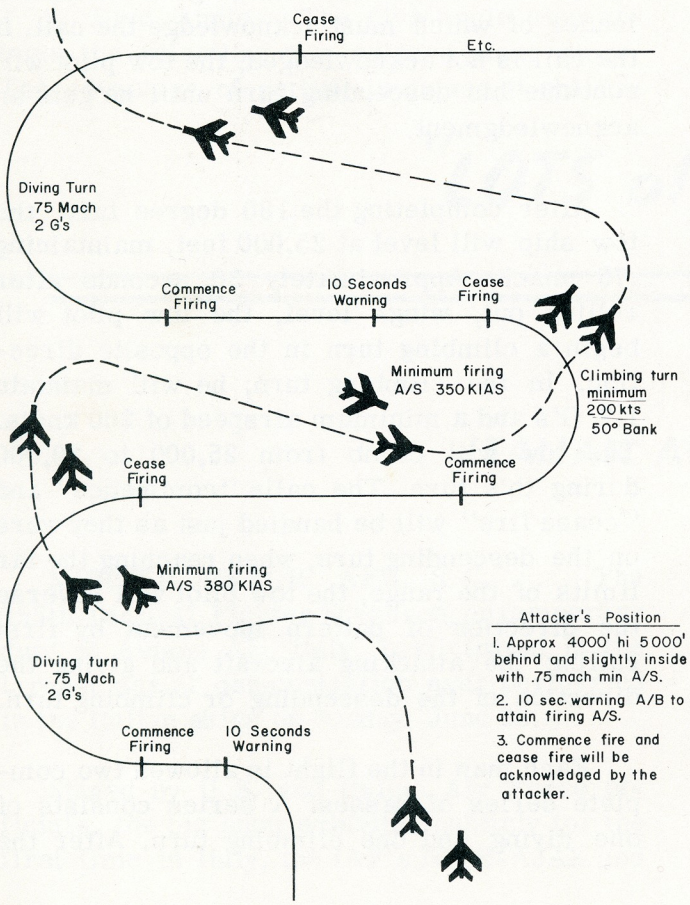
After completing the 180 degree turn, the tow ship will level at 25,000 feet, maintaining .75 mach. Approximately 30 seconds after rolling out, wings level, the tow pilot will begin a climbing turn in the opposite direction. In the climbing turn, he will maintain 1.2 G's and a minimum airspeed of 200 knots. The tow will climb from 25,000 to 30,000 during this turn. The calls "commence" and "cease fire" will be handled just as they were on the descending turn, when reaching the far limits of the range, the tow pilot will reverse the direction of pattern movement by first calling the attacking aircraft and giving the direction of the descending or climbing turn.

Each man in the flight is allowed two complete series of passes. A series consists of one diving and one climbing turn. After the

attacker has completed three passes, he will notify his wingman that the next pass will be his last. After completing his fourth pass, the attacker will slide high and wide to allow his wingman to move down into the attack position. At this time, the wingman will assume the role of the attacker and the first attacker will become the wingman.

In the pattern, as it is used here in the Fighter Weapons School, there is an optional radio call that may or may not be utilized. It is a call from the tow pilot giving a 10 second warning prior to beginning his turns. Since this pattern is fairly tight and does require a great deal of planning to make a series of successful passes, this 10 second warning is, in most cases, a welcome crutch. So much for the pattern itself.

In our discussion of how to best position ourselves for a successful pass on the target, let's assume that we are flying the aircraft that is going to do the actual firing. We are on the "perch," waiting for the tow to begin his descending turn into us.


Cease Firing
Etc.
Diving Turn .75 Mach 2 G's
Commence Firing
10 Seconds Warning
Cease Firing
Minimum firing A/S 350 KIAS
Climbing turn minimum 200 kts 50° Bank
Cease Firing
Commence Firing
Minimum firing A/S 380 KIAS
Diving turn .75 Mach 2 G's
Commence Firing
10 Seconds Warning
Attacker's Position
1. Approx 4000' hi 5000' behind and slightly inside with .75 mach min A/S.
2. 10 sec. warning A/B to attain firing A/S.
3. Commence fire and cease fire will be acknowledged by the attacker.

When the tow pilot gives us our ten second warning, we drop the nose and light the "burner." This will give us our minimum firing airspeed and will also help us to get into range and fire during the target's first 90 degrees of turn.

The reason we want to fire during the first 90 degrees of turn is this; if we fire on the last portion of the turn, just about the time we break off and begin our steep, maximum performance climb, the tow ship will roll wings level and there we'll be almost on top of the target with practically no lateral separation. The first time this happens to you, the old saying "you can't get there from here" will seem very appropriate. Of course you can "get there" from this position and we will discuss a little later how it can be done with a minimum of strain.

Since we are beginning our pass immediately after getting the ten second warning from the tow, by the time he starts his turn and clears us to fire, we are within about 3,000 feet of the target and have our closing airspeed. Remember, that if your firing airspeed is above .96 mach, you are exceeding the capabilities of the A-4 sight. If your closing airspeed is around .97 or .98 mach, the increased G loading, as you press into the target, will dissipate the airspeed slightly and you should be operating within the sight's capabilities as you fire.

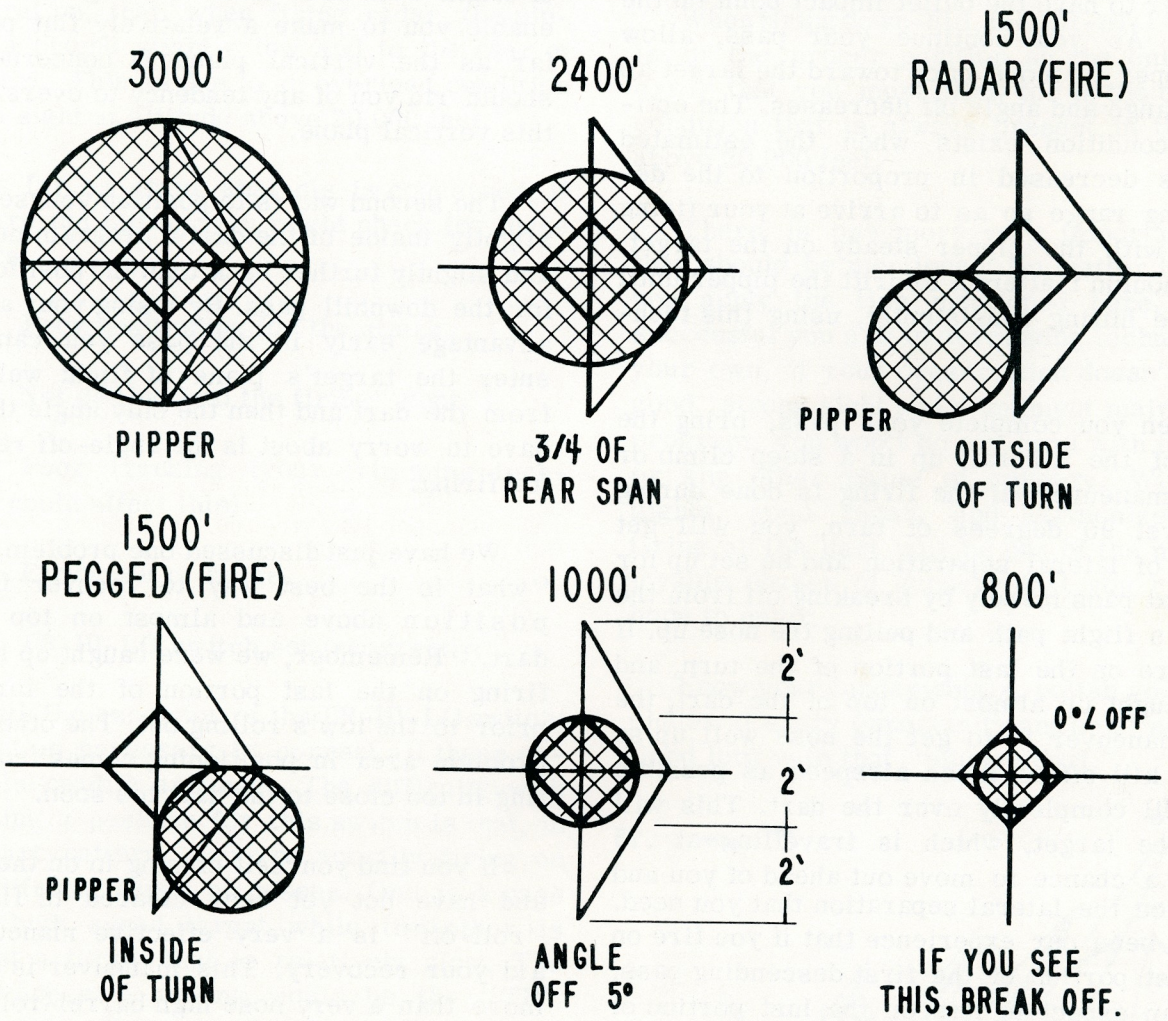
The most popular technique for pipper control, during "lock-on" when using the normal radar function, is to crank the sight down to 2400' and place the pipper slightly in front of the target. Allow the pipper to drift back slowly so that it will be on the target at a range of 2,400 feet. The pipper will cover approximately three-quarters of the rear height of the target at this time. Release the throttle to radar ranging and the pipper should remain

on the target. If your range is greater than 2400 feet, the pipper will drift back behind the dart. The normal tendency is to pull the pipper up to the target, but if this is done, almost invariably, the pipper will move out in front and there won't be enough time in which to recover, track and fire, if the pipper is only slightly behind the target, just continue your smooth rate of turn and, as you close on the dart, the added stiffness being fed into the sight, due to the decreasing range to the target, will move the pipper up to the target.

If the throttle is released when the range is less than 2400 feet, the pipper will move ahead of the target. To correct this condition, an immediate correction is necessary. Do not dump the stick in an attempt to get the pipper on the target, but use a smooth positive correction. Track the dart and fire a one-half to three-fourth second burst when within range. The best range for this type pass is between 1500 and 1200 feet. In a pass of this type, you can expect to pull between 2 and 4 G's depending upon your angle-off, of course.

You will find that your passes will be much more comfortable if you will fly a pursuit

DART SIGHT PICTURES



curve that requires no more than 3 1/2 G's to track the target. Besides the problems normally associated with high-G tracking; it has been our experience that in turns requiring high angles of attack, the majority of yaw-dampers will not afford the stability that is required to do a good job of tracking.

If you are firing with a pegged sight, I recommend that you range down to 1200 feet and hold it throughout the pass. As you are closing on the dart, place the pipper approximately one-fourth cable length ahead of the target. This will help you stay away from that "square corner" just as you are about to fire. Your firing range must be within plus or minus 150 feet of your pegged range in order to have the bullet impact point on the target. As you continue your pass, allow the pipper to move back toward the target as your range and angle off decreases. The optimum condition exists when the estimated lead is decreased in proportion to the decreasing range so as to arrive at your firing range with the pipper steady on the target. You shouldn't attempt to drift the pipper until you are hitting consistently, using this technique.

When you complete your pass, bring the nose of the aircraft up in a steep climb or YoYo maneuver. If the firing is done during the first 90 degrees of turn, you will get plenty of lateral separation and be set up for the next pass merely by breaking off from the target's flight path and pulling the nose up. If you fire on the last portion of the turn, and are caught up almost on top of the dart, the best maneuver is to get the nose well up so as to kill off as much airspeed as possible and roll completely over the dart. This will give the target, which is travelling at .75 mach, a chance to move out ahead of you and give you the lateral separation that you need. It has been our experience that if you fire on the last portion of the first descending pass, you can expect to fire on the last portion of the climbing pass. By this, I mean that you should more or less disregard the first portion of the climbing turn and plan your attack so as to be in a position to fire at about the 90 to 120 degree point. If you attempt to fire on the target in the first portion of the climbing turn, you will find that the target is climbing as you are diving and you will have a strong tendency to go right out the bottom of the pattern.

There are two relatively simple ways to avoid this problem. The first way is to have your "perch" or "attack" position on the outside of the tow aircraft and not quite so high as it was when we were preparing for the downhill pass. Two thousand feet above the target's altitude should be about right. The objective here is to intercept the dart's plane of flight well back from the target. This will enable you to make a relatively flat pass as far as the vertical plane is concerned and should rid you of any tendency to overshoot in this vertical plane.

The second way is to position yourself only slightly inside of the dart's programmed turn and slightly further back than the position used for the downhill pass. By losing your altitude advantage early in the pass you can again enter the target's plane of flight well back from the dart and then the only angle that you have to worry about is the angle-off required for firing.

We have just discussed one problem area - "what is the best way to recover from a position above and almost on top of the dart." Remember, we were caught up here by firing on the last portion of the turn just prior to the tow's rolling out. The other main problem area in positioning comes from getting in too close to the dart too soon.

If you find yourself closing in on the target and have not yet been cleared to fire, the "roll-off" is a very effective maneuver to aid your recovery. This maneuver is nothing more than a very nose high barrel-roll in the direction opposite to that of the tow ship's

turn. After using this maneuver, you will find that the last portion of the target's turn is where you will want to catch and "hose" him.

Almost everyone firing on the dart for the first time has a tendency to fire a little out of range. An excellent way to get away from this is to make your first pass "dry" and concentrate on tracking and the size relationship between the pipper and the target. Close in until the pipper is the size of the reflector on the rear of the target—a relationship which indicates a range of approximately 1000 feet. We have found that this one pass aids tremendously in range estimation on all subsequent flights.

You will notice, on the dart sight picture illustration, that, when firing radar, the pipper is placed slightly low and to the rear of the dart. This is due to an overlead condition in the sight at altitude above 20,000 feet.

As far as error analysis is concerned, if you are not hitting, you might check for these errors.

1. Poor positioning for the attack.

2. Not getting into the firing "cone."

3. Poor tracking (your trimming technique could affect this).

4. Firing out of range.

5. TR-HI-LO switch set incorrectly.

With the exception of the TR-HI-LO switch, the action necessary to correct all these errors is readily apparent. The difficulty with choosing a position for this switch is that, in the dart pattern, you are actually firing on two different types of passes. One is a pass on a high speed target while the other is against a target that is relatively slow. The most accurate setting would be the "TR" position for firing on the down-hill pass and the "LO" when firing up-hill.

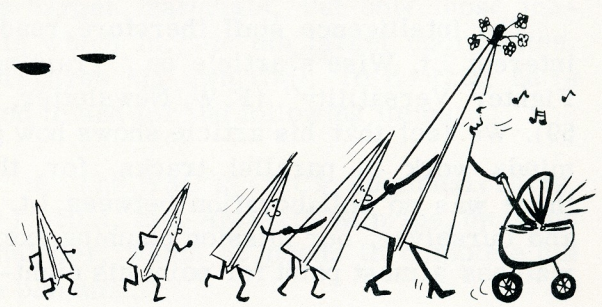
Since most of us are plenty busy just positioning ourselves for an attack, the majority of us use one compromise setting. This is usually the "TR" position, which requires that we change our tracking point slightly on the up-hill pass.

When making a low-target-speed type of attack, with the selector switch on "TR," the bullet impact point will be slightly above and behind the pipper. Under these conditions, it can be seen, when firing radar on the climbing turns, that the pipper will have to be placed on the bottom center of the dart. When firing pegged on the climbing turns, the pipper should be placed on the lower front portion of the target.

When firing down-hill, the TR-HI-LO switch is in the proper position so the only slight error that you must allow for is the overlead condition that is always present in the sight above 20,000 feet.

There is one more very important point that should be mentioned: No matter how well you apply the tips mentioned here, or how successful you are in developing techniques of your own, if your organization doesn't have a good, strong sight and armament maintenance program, you won't do any good with the dart, or any other phase of gunnery. With good sights, good radar, and harmonized guns, firing at the dart will be one of the most enjoyable phases of gunnery that you can ever hope to enter.

Know your fundamentals, polish your techniques at every opportunity and be a "scorer." Good luck with that "elusive dart."



b. Equivalent target materials on check points en route. 1:10M TI's are available on two of the check points. This isn't actually doing much good insofar as our missions are concerned, but the pilots deploying overseas will be accustomed to the technique. We emphasize that check-point location and identification is much the same as target location, and deserves the same care and study.

The CMI preparation follows the TAC-suggested SOP, complete to preparation of route navigation charts based on sectionals and the dash part of the course planned on the 1:50M maps. Also required are TAC-developed perspective sketches, and terrain profiles accurate to 200 feet on the route and 40 feet on the dash. We find the perspective sketches a valuable aid to target study.

The EWP test follows the standard TAC pattern, and a score of 95% is required before the pilot is certified ready to fly the mission. Scoring is so arranged that the real passing test is to convince the Intelligence Officers that the pilots know their routes cold, and depends particularly on being able to give a complete and accurate oral description of the run-in from memory, with times calculated to tenths of a second.

The pilots then go out and fly the mission. A successful mission Intelligence-wise is one in which the pilot pulls up over the target. Difficulty of the target is indicated by the fact that on the first class of students, two to one odds were bet against successful accomplishment of the missions; success of the EWP study technique is indicated by the fact that at the time of this writing (1 July 59) 43 student pilots had flown the mission with six failures for a success rate of 86%.

As a consequence of this rate of success, we now believe that where target materials are adequate, the targets are accurately located, and mission planning is adequately performed, an experienced pilot should never fail to locate his target. Our students do miss occasionally; each case is investigated to find out why. Also, after leaving Intelligence training they sometimes miss; insofar as possible these cases too are investigated.

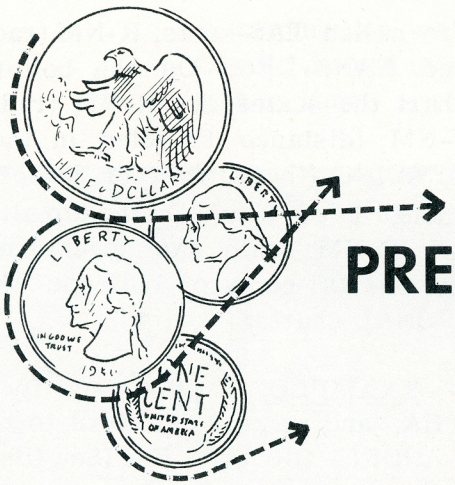
The mission planning exercise consumes 12 hours' planning time. The full time is required by the average pilot; indeed, in order to stay within the 12 hours' time the problem must be limited to the extent that we do not require the same exhaustive study of the en-route course and check points. This is undesirable, of course, for the route study is fully as important as the dash (we have found out how easy it is for a pilot to get lost). An objection to our program is that twelve hours is too much time to allot for study, that a pilot will not ordinarily have time to do this. The objection is valid to a degree, but we have a three-point reply to it:

a. This exercise simulates the pre-planned EWP target study, for which unlimited time is available and for which TAC requires 24 hours' study.

b. We attempt to be exhaustive, bringing in a simulation of every Intelligence planning factor which could affect the problem. Such extensive simulation is not usually employed in training situations, though it should be and often is.

c. The procedures we teach are adaptable to daily operations, and we agree that an experienced pilot may well be able to accomplish the minimum preparation for flying against a Nellis target in less time; we feel, however, that any pilot is wasting his time lifting wheels off the runway if he tries to get by on less than two (2) hours' preparation.

Intelligence and Operations Officers experienced in TAC EWP target study procedures will see that there is nothing original or unusual in our training program. It is merely an application of long-standing procedures under conditions such that the efficiency of the method can be tested in an exercise, a thing that tactical wings usually cannot do. We can conclude that the TAC EWP target study program works; and that it works when applied by pilots of the lowest skill level in TAC.



PREFLIGHT PLANNING for TURNS

By: 1st Lt. Clyde R. Robbins
307th Tactical Fighter Sq.
George AFB, California

Every observant pilot knows that an aircraft cannot make square turns. Then, to be precise in our navigational planning we should somehow account for the distance an aircraft covers and the track it takes over the ground in a turn. My object is to present one of the many possible solutions to this problem. The answer presented is considered the most suitable for fighter type pre-flight planning.

I. THE GENERAL PROBLEM:

1. When flying a low level mission a pilot normally will fly his planned track up to a given check point and then turn to a new heading which should take him to the next check point. Whether this new heading takes him to the correct place or not depends on the turn just made and how precisely he can fly the track he has drawn for the turn.

2. Many pilots have drawn these on their charts with coins. Each pilot knew only vaguely the angle of bank and airspeed required to fly the turn he had drawn. Naturally these notions of the correct relationship between these three variables have not always been correct. There has also been some difficulty measuring this distance traveled in a turn. These problems will be considered here.

II. EQUATIONS INVOLVED:

1. The equation relating the three important variables, in turning flight, can be readily derived.

$$R = \frac{1.475 \times 10^{-5} V^2}{\tan B}$$

R = Turn radius -- Nautical Miles

V = True airspeed -- Knots

B = Angle of bank -- Degrees

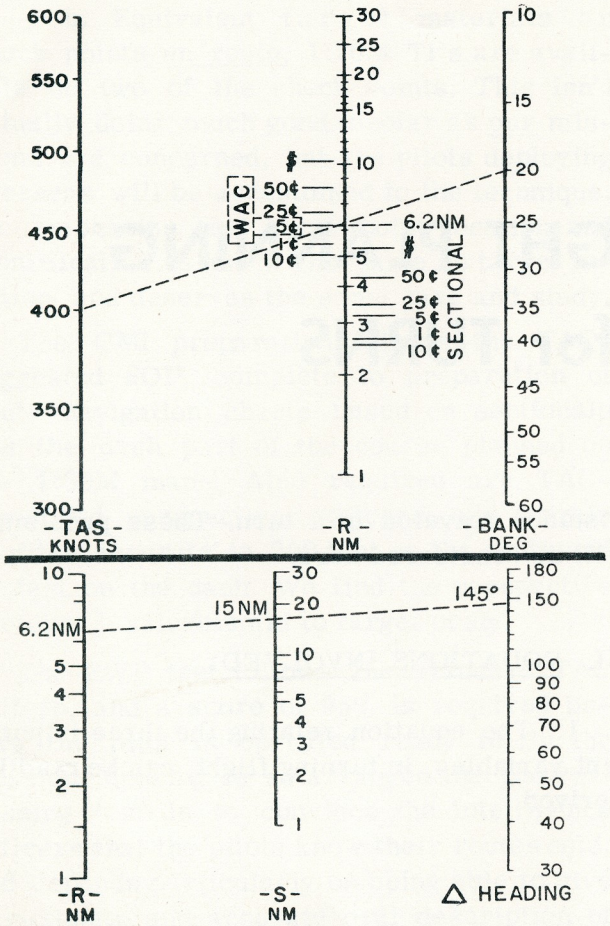
2. The equation for distance traveled in a turn can be derived also.

$$S = 1.745 \times 10^{-2} R \Delta H$$

S = Distance traveled in turn -- Nautical Miles

Δ H = Change of heading -- Degrees

3. These two equations solve the problems but must still be put in a useful graphical



form. These equations are subject to the following conditions:

a. True airspeed must equal ground speed, that is to say, ignore wind effects.

b. A constant speed level turn is required.

III. CHOOSING A PRESENTATION: The presentation of the information given by equations (1) and (2), to be usable by fighter pilots must be simple and consume as little time as possible in its use. The alignment chart (Fig. 1) meets both requirements.

IV. USING THE CHART: The alignment chart consists of three or more scales of numbers which solve a relationship between the variables when a straight line is drawn on the chart. On the top alignment chart the scales are called TAS-knots, R-NM (radius of turn), and BANK-DEG. On the bottom alignment chart the scales are R-NM (radius of turn), S-NM (distance traveled in the turn), and HEADING (the number of degrees of heading change in the turn). On the top alignment chart the R-NM scale has special markings for various US coins on both the WAC and SECTIONAL charts.

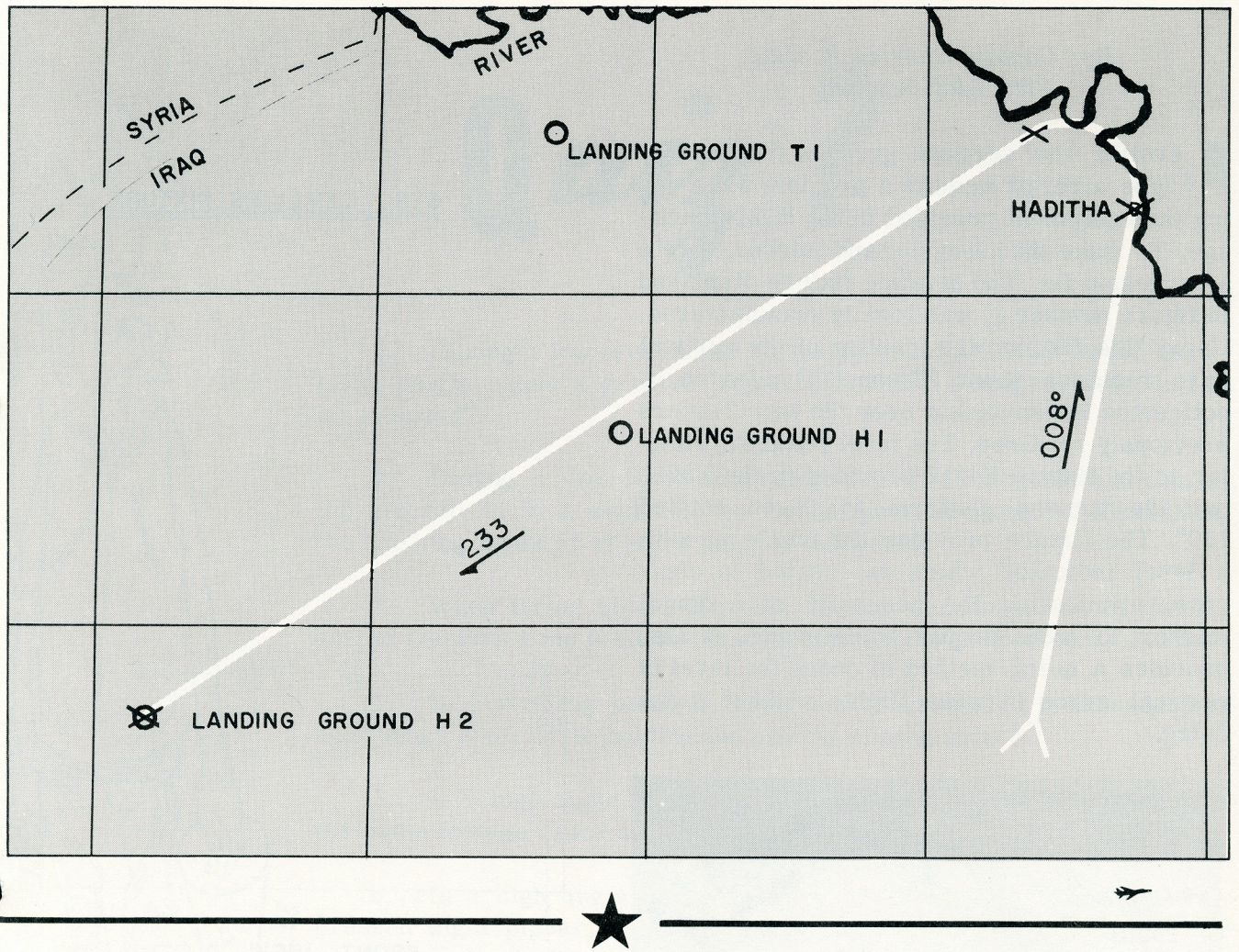
EXAMPLE: A pilot must fly over HADITHA, and make a left turn to the next point LANDING GROUND H-2 (See Illustration 2 on following page). He draws this turn on the WAC chart with a nickel from his pocket. Next he measures this heading to and from HADITHA, 008 degrees and 233 degrees respectively. He plans to make good a 400 knot ground speed. On the alignment chart he places a straight edge through the known values (400 knots) and a nickel on the WAC chart and determines that 20 degrees of bank will fly the track he drew with his nickel. Other information presented is that a nickel has a radius of 6.2 NM on a WAC chart.

He has turned 145 degrees and to determine the distance traveled in the turn he now used the bottom portion of the alignment chart. The distance traveled in the turn is 15 NM. By adding the 15 NM to the remaining 97 miles to LANDING GROUND H-2 the leg becomes 112 NM and the ETE is accurately then calculated since a reasonably accurate distance measurement was made.

Now the pilot needs only to remember that he must turn with 20 degrees of bank and maintain a ground speed of 400 knots. He will roll out of his turn on track and on time with an accuracy unobtainable by more crude planing methods.

The alignment chart is useful in solving any problems of turning flight as long as its restrictions are understood. One example of its use was related to a fly-by. The formation leader wished to lay out an orbit to hold before his IP to make the pass. The alignment chart

in conjunction with a local area SECTIONAL CHART helped to select a good orbit. The pass was on time.



LABS GYRO MOD

An Engineering Change Proposed (ECP) has been submitted from Minneapolis-Honeywell to AMC for a modification of the LABS vertical gyro. A prototype of the vertical gyro was delivered to Nellis AFB from WRAMA for AMC evaluation and received a 100% acceptance from the pilots.

The modification consists of a 45° plastic prism with reflector and a captive screwdriver installed in the cover of the LABS vertical gyro in place of the present plastic window over the release angle adjustments. The 45° prism and reflector allows the pilot to easily see the release angle settings for both the normal and alternate sectors. The captive screwdriver has a knurled knob for easy adjustment and is aligned with the adjusting screw at all times. This design was primarily for the F-100D due to the inaccessibility of the gyro on the "D" aircraft.

The new gyro will be designated as JG7044N3.

New Gyro Leveling Fixture . . . . .

By: Captain Charles R. Hale
FWS A&E Section

Leveling the vertical gyro in the F-100D type aircraft is quite a problem when using the equipment provided in the E3216 package. To make the job easier and quicker, here's a suggested fix. The leveling fixture displayed in figure number 1, was locally manufactured. Using this fixture, the leveling of the vertical gyro requires about fifteen (15) minutes, a noticeable improvement over the two (2) hours previously required. The level fixture is similar to the fixture E4210 provided in the E3216 package but the platform has been rotated 180°. The fixture provides the mechanic with a level indicator which is located in clear view, eliminating the necessity of a dental mirror to make proper adjustments. It also provides a quick method to check the level of vertical gyros between flights without undue delay.

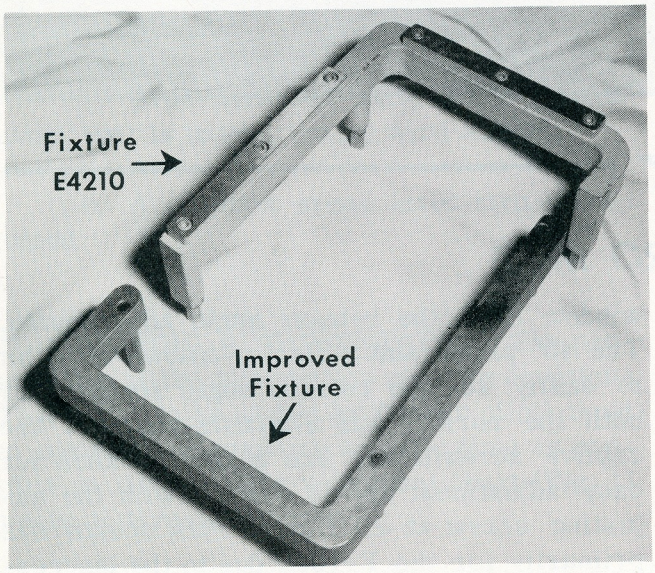
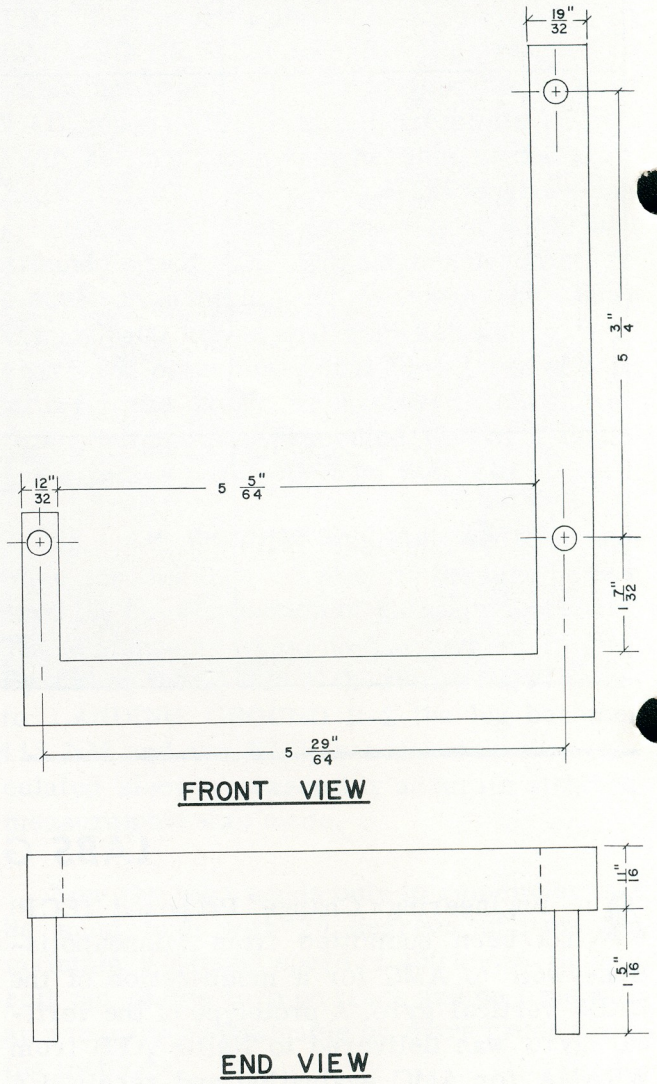
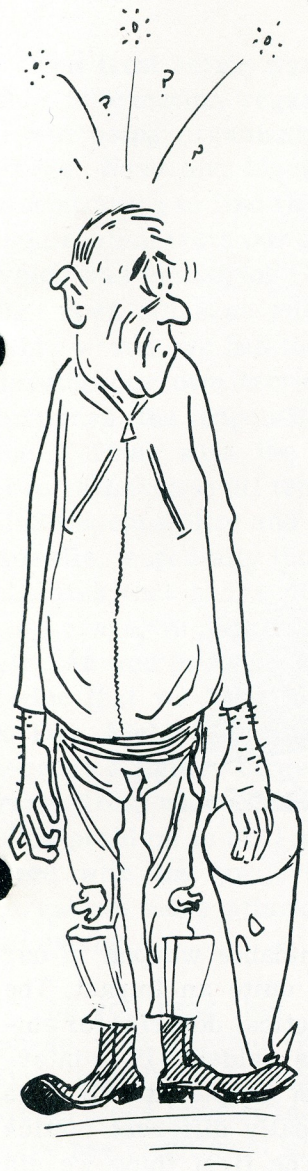


Figure 1

GYRO LEVELING FIXTURE





Quiz ?

1. During a low level bomb delivery, would a 20-foot error in release height cause a greater impact error than a 20K variation in release speed?

2. During a low level bomb delivery in a no-wind condition, if the aircraft is in a skid will the impact point be along the flight path, the tracking index or at some point in-between?

3. When firing air-to-air with 20 mm cannons, what is the required tracking time to allow the sight to make the proper computations?

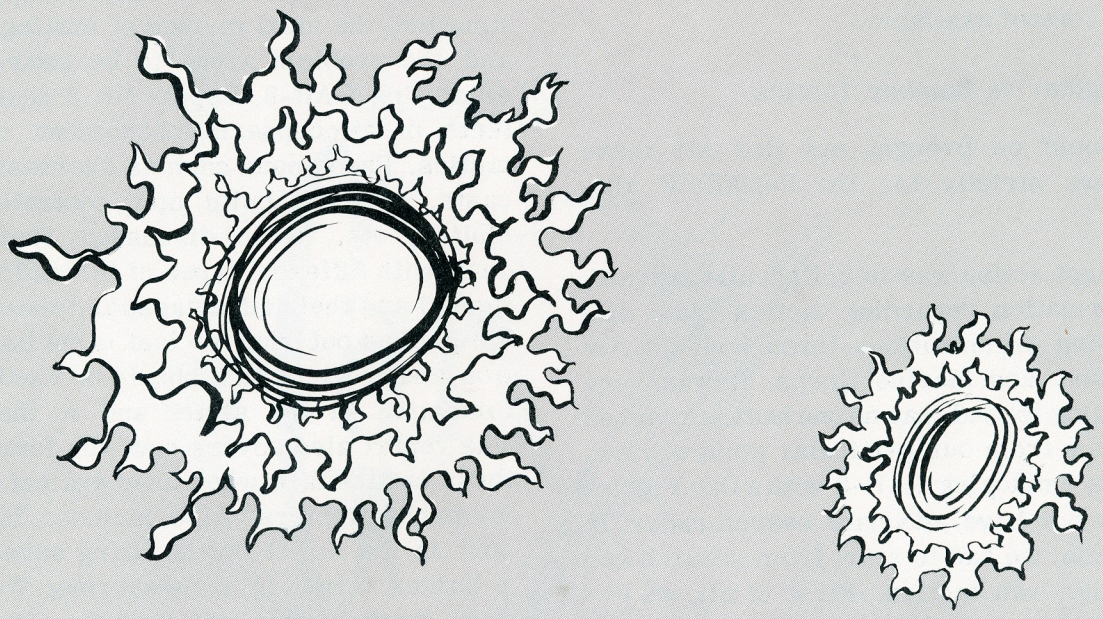
4. In a strafing pass, if there is a crosswind, is it necessary to hold wings level while holding the upwind aiming point?

5. In a high angle bomb delivery would a 5 degree underdive give the same footage error as a 5 degree overdive?

6. In a high angle bomb delivery, if tracking the target with depressed sight pipper, is it necessary to have wings level at release?

7. If a rocket is launched from an aircraft that is in a skid, will its path be closer to the rockets launching line or the aircrafts flight path?

ANSWERS ON PAGE 47



TEMPERATURE VERSUS INFRARED

By: Captain Robert M. Thor
TR&D Section

Infrared guided missiles are now operational in both TAC and ADC. If maximum effectiveness is to be realized from these missiles, it is important that all personnel concerned have a general understanding of the effect of temperature on infrared detectors (photoconductor cells). The temperature of the photoconductor cell can determine its sensitivity to infrared radiation, and that portion (wavelength) of the infrared spectrum to which it will respond. Since the infrared detector is the heart of the guidance system, its sensitivity will directly affect missile performance.

Photoconductor cells are sensitive to infrared radiation that is emitted in the form of heat from the target. Discounting atmospheric effects, the sensitivity of a photoconductor cell will determine the range at which it can detect a target of given temperature. As the temperature of the photoconductor cell increases, its sensitivity decreases, and if it becomes hot enough, it will be completely insensitive to infrared radiation, hence missile guidance is impossible. As the cell cools, its sensitivity will return. It is evident that the temperature of the photoconductor cell may well determine the maximum range of the missile.

To alleviate this problem we must use caution to prevent exposing infrared guided missiles to high temperatures. In warm climates, ready missiles should be protected from the direct rays of the sun, and protective covers should be left on the missiles until flight. Avoid the hot exhaust gases from other aircraft while taxiing and taking off. If the photoconductor cell does become overheated, it will require a considerable amount of flight time to cool it down before it will regain its sensitivity. Remember -- even though infrared guided missiles guide on a heat source, they won't work if they are hot!

QUICK, DIRTY and CHEAP

By: Captain W. D. Druen
TR&D Section

The problem of having a smooth transition between the radar and the range servo-mechanism has been with us since the advent of airborne radar as a main source to obtain range information. The radar has always locked-on at a range greater than that of the rest range (range the sight receives prior to radar lock-on) thereby causing pipper displacement during transition which is not conducive to smooth tracking. Many methods of attaining a smooth transition have been tried with varying degrees of success. As far as the F-100 equipped with the APG-30 and 30A radar is concerned, it started in 1954 when North American Aviation came up with their controlled sweep modification. This mod was used in TR&D Project 57-4 (Investigation of MA-3 Fire Control System Problems) on the APG-30 radar with a large degree of success. Then came the APG-30A radar. Many problems arose with the largest being an internal lock-on when a 2,850' rest range was used. Reference TR&D Project 57-9A, F-100D/F Air-to-Air Gunnery Evaluation. Many outfits had mods to the mod in an effort to have a smooth transition between radar and range servo. Some worked well at times, others didn't have the same luck. The 36th Gunnery Team came up with a mechanical stop for the range servo to solve the problem of transition. They had a few other sophistications that aided the pilot in his firing pass, but we are interested only in the problem of the smooth transition between the radar and the range servo. This mechanical stop worked well and was installed in several of our TR&D range servo units. These units, again, worked well, but after repeated sorties, a noticeable "jump" occurred at transition. Upon closer investigation, it was discovered that due to the mechanical stop being placed on the range servo gear, the main gear in the servo was being stripped. Naturally, we could not afford this due to the shortage of servo units, so another method was down the drain.

Thus entered the duo-diode tube. Mr. Gene Moore, RCA sight tech rep for the Fighter Weapons School, approached the transition problem from strictly a voltage standpoint. By using the series of resistors in the range computer, he produced 24 volts (which is equivalent to 2,850 feet) to give a 2,850 foot rest range. This mod is accomplished by installing a duo-diode vacuum tube (6AL5/5726) on the range computer chasis, utilizing the existing mounting screws and a local manufactured aluminum mounting bracket. (See Figure 1)

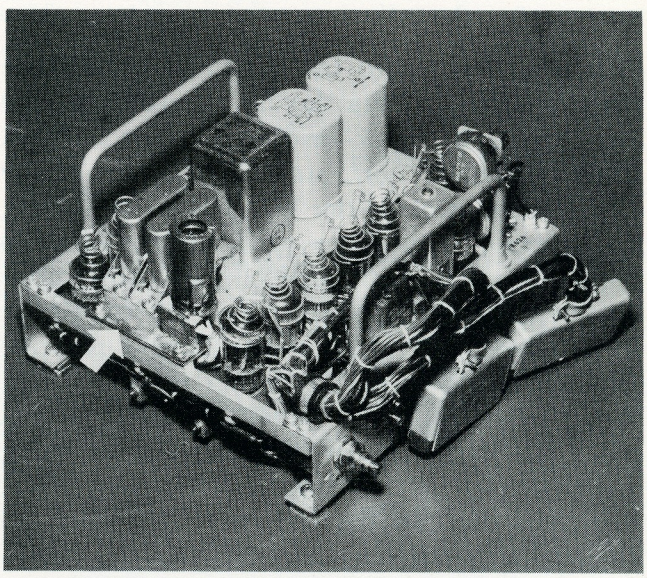


Figure 1

To get a little technical, let's get into the nuts and bolts of this mod. By studying Figure 2, we see that by connecting the diode cathode pin to the common contact of K602B, lock-on relay, and the plate to the rest range tap, between R-649 and R-648, the range voltage out-

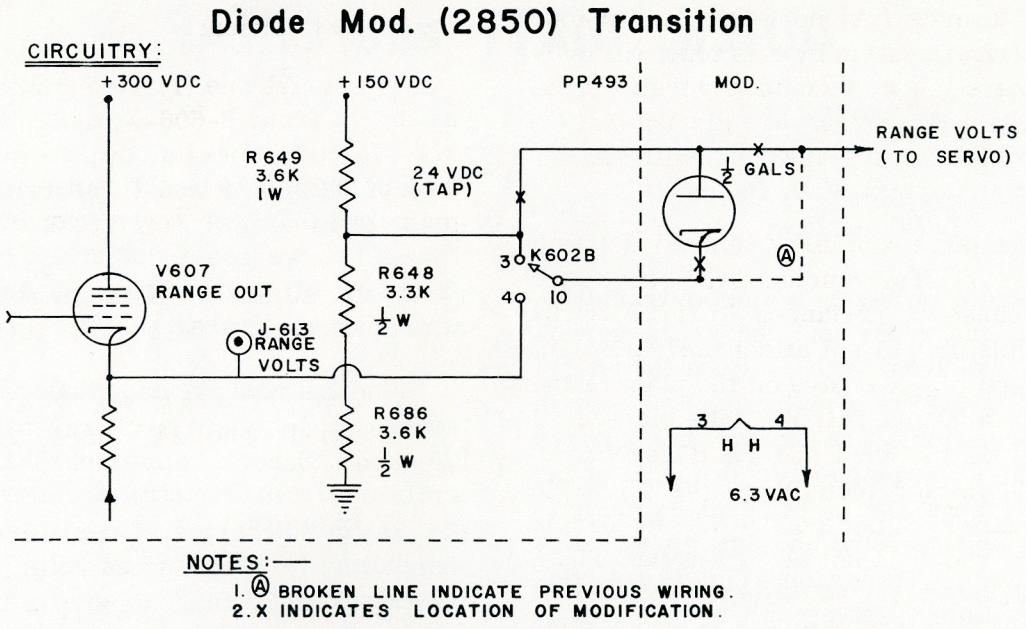


Figure 2

INSTALLATION:

1. *Mount 7-pin tube socket and hardware (w/local mfg. mount) to existing screws on range-computer sub-chassis.*
2. *Wire socket as shown with approx. 12" AWG No. 22 conductor (ins.).*
3. *Installation requires approx. 30 min.*

line is connected to the rest range and diode plate junction. Thus during the radar range sweep, no radar lock-on occurs since the rest range potential controls the position of the range servomechanism. When lock-on occurs, the output of the range output tube (V607) is connected to the cathode of the added diode tube. This diode tube will not conduct until the potential at the cathode becomes less positive than the plate potential, which is 24V (2,850' rest range). In other words, the range output tube will not position the range servo until target range is 2,850 feet (24 volts or less). Thus, lock-on can and will take place as normal, however, no range information will be received by the range servo until 24V (2,850') is reached. Range information will continue down to 10V (700') at which time radar break lock occurs.

As you can see, this is as the title implies, quick and dirty (the cheap we will cover in a minute). The mod could be sophisticated very easily to give different voltages for different rest ranges. A means to determine approximate firing ranges could be incorporated to aid the pilot, such as the one shown in Figure 3 (This has not been incorporated in the TR&D aircraft and has not been flight tested.) As the mod operates now, the first and only indication to the pilot that transition has occurred and radar range information is being obtained by the sight, is the increase in size of the reticle as range decreases. Personally, I believe this is ample for the experienced pilot, but it might not be sufficient for the novice jockey.

As to the cheap portion of the title, the diode tube, retail, costs $1.50, the socket 39 cents and the 12-inches of number 20 wire needed about 24 cents. There is also the locally manufactured aluminum bracket with screws. All in all, not over $3.50, is that cheap enough? As to manhours for installation, that comes to one-half of one manhour.

Of the three sets we have modified in this section, ample sorties of all kinds have been

registered to ascertain no undue load placed on the electrical system by this tube. No malfunctions have been accounted to the tubes and the only malfunctions are the normal (?) radar and sight write-ups that will and do arise.

The advantages are many and to list as a few we have: (1) Tolerances of the rest range voltage because of variances in the aircraft voltage regulator will not affect the transition. If 23.5 V are all you have on the plate of the tube, then transition will not take place until this voltage is matched and the difference in range would be undetectable to the pilot. (2) The range gate is outside of the dunking period because the radar is not being limited. Thus, there is little or no possibility of the internal lock-on that has been the case in other electrical type mods. (3) The reliability and stability should be increased because there is no additional energy expended to overload existing circuitry or mechanisms. The diode tube is operating at approximately 1/6th of maximum rating and approximately 1/2 typical operational characteristics of the tube. This modification is no cure all for sight and radar malfunctions but it may help increase scores when firing air-to-air gunnery. At least you won't have to worry about using the 2,400' transition method or the electrical cage transition method, just roll in, put the pipper on the target (still no fix to assure this), track and fire.

The troops in Tripoli are giving this a try right now and we are anxiously awaiting their results. If you happen to try it in the meantime, be sure and let us know how you make out. Until then, may all your write-ups be O.K.

IN-RANGE FIRING LAMP

1. With this feature incorporated, the radar lock-on indication will be brightening of the reticle, thus the illumination of the normal lock-on light will be the in-range indication.

2. Installation:

a. Add one (1) wire approximately 24'' in length from P-606-N, splice to T-6 of TB-202. Remove lock-on line to sighthead from T-5 of TB202. Place these two wires on the open terminal of T-6 of TB202.

b. Adjust CAM in range servomechanism to actuate S404 at 1500' thru 900'.

3. Cost: This mod requires approximately 1/2 manhour and 24'' of 20 AWG-Stranded aircraft wire.

4. Circuitry:

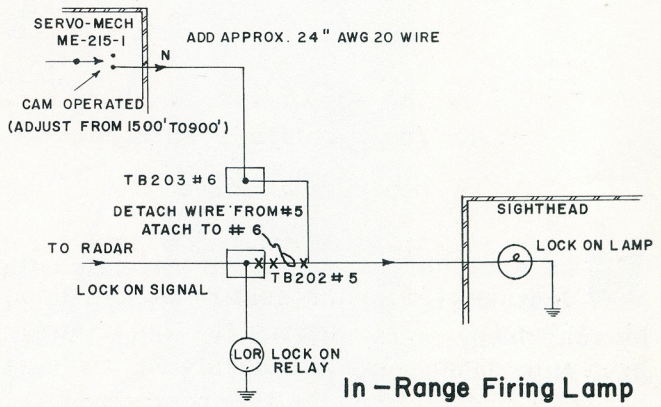


Figure 3

ANSWERS TO QUIZ:

1. Yes

2. Along the flight path.

3. .51 to .96 seconds. As a rule of thumb 2/3 the time of flight of the projectile.

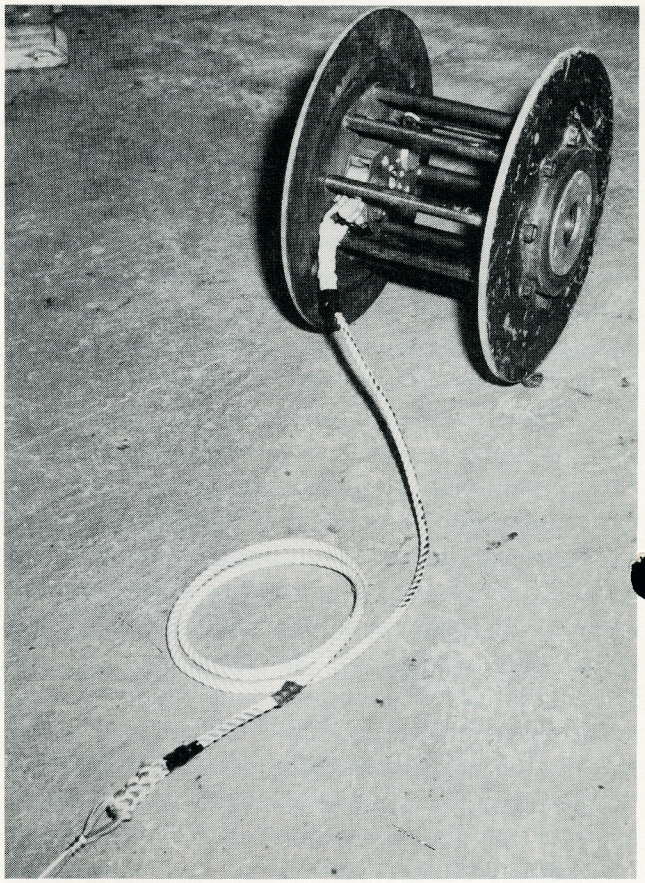
4. No.

5. No. Underdive gives a larger error than overdive.

6. Yes.

7. Closer to the aircrafts flight path.

DART TOW CABLE MOD



By: Captain John C. Holley
TR&D Section

Has your unit been plagued recently with lost darts due to cable breakage at launch? Many units in TAC, including Nellis, have experienced this trouble.

The beginning of our troubles coincided with the receipt of a new lot of cable, which was manufactured by the Robling Company in New Jersey. Upon investigation, it was found that this cable has a breaking strength of only 2000# compared with a 2250# breaking strength for cable manufactured by American Cable in Los Angeles.

If you are having breakage trouble with cable manufactured by the latter company, you'd better re-check your pilot procedures for dart launch—assuring that flaps are used and that launches are made at a maximum of 190 knots with no acceleration for approximately 60 seconds after launch. However, if you are using the Robling manufactured cable, the following fix, which is being used in the USAF Fighter Weapons School, should be of interest to you.

All of our breaks were occuring at the guide pulley upon completion of wind-out. The following "fix" ended our troubles:

Insert 7 to 10 feet of nylon rope (the same type as used on the dart end of the cable between the wind-out spool and cable. Make the cable connection with a 1/8 inch metal thimble, then compress the junction in a vice. The rope should then be wound tightly around the spool and taped to the spool, leaving the thimble available to facilitate cable hook-up.

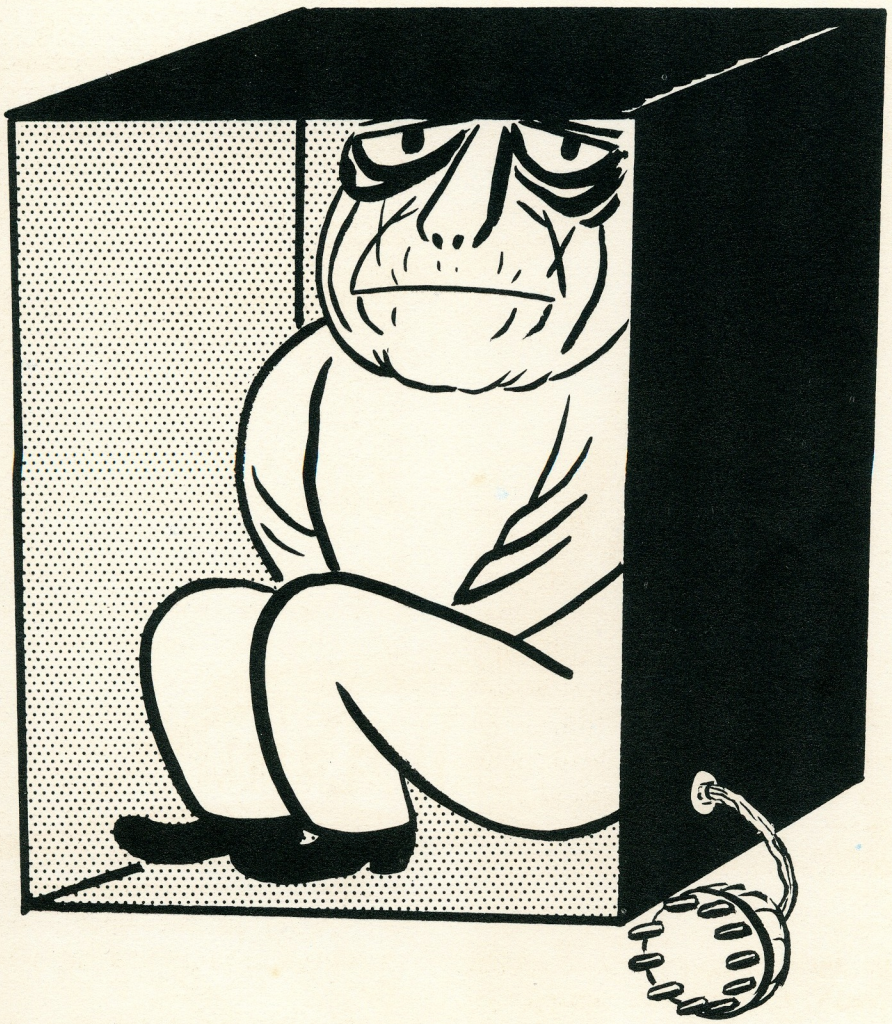
Requests for information regarding procurement of tow reels, dart targets and associated equipment should be sent to:

OOAMA - NFMA

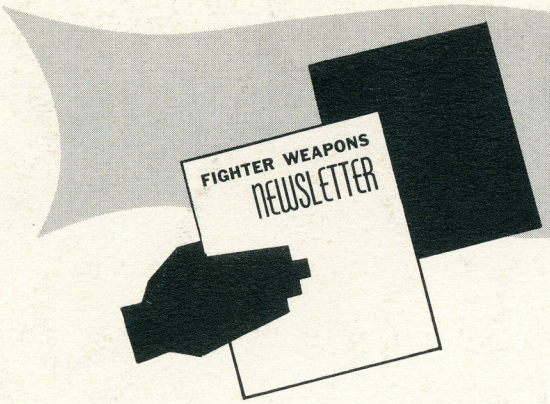
Hill Field

Ogden, Utah

3500 FPS-6151



BLACK BOX TO REPLACE PILOT



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